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INDEX

Note—Illustrated articles are marked with an (*) asterisk.

Advantages of motor trucks for use on steamship piers. Patten..... 447
Aeronautics in relation to naval architecture 541
Alaska coal for marine service, fuel values of. Allison..... 398
Alquist gearing for ship propulsion. Emmet *536
American Bureau of Shipping..... 251
American Bureau of Shipping, new members and managers of..... 478
American Bureau of Shipping, scope of widened 520
American-designed working boat for Cartogena, Colombia, S. A..... *487
American International Terminals Company 440
American merchant marine. Nolan..... 317
American merchant marine, new and constructive policy of building the. Baker. 112
American Shipbuilding Co..... 141
American ships, world-wide demand for. Taylor 523
American shipyards and marine repair plants 113
Analysis of the Shipping Bill. "Old Scotch" 107
Annie Johnson, auxiliary schooner..... *407
Antwerpen, oil tank steamer..... *491
Application of DeLaval high speed, reducing gears to turbine drive on board ship *339
Army collier, No. 1, United States..... *184
Army transport McClellan, conversion into a refrigerator ship. French..... *189
Auxiliary motor ship City of Portland. McAlpin *292
Auxiliary schooner Annie Johnson. Perkins *407

Baltimore shipbuilding plant reorganized *129
Barge canal 436
Barge No. 2, Canadian government hopper *53
Barges and boats for river navigation, shallow draft. Beach and Kellar..... *53
Barges, resistance of. Sadler..... 547
Bath's leading shipyard..... *118
Battleship Nevada, United States..... *155
Better docks for less money. Farrand.. *468
Bids for new warships..... 482
Boats and barges for riven navigation, shallow draft. Beach and Kellar.... *53
Boilers, dry steam in Scotch—remarkable performance of..... *205
Boilers on steamship Minnesota, new.... *493
Boiler, test of Ward watertube. Robinson *330
Bristol, steamship, remarkable performance of—dry steam in Scotch boilers.. *205
British fleet—naval preparedness. Sinn.. 314
Bulk cargo steamer Chokyu Maru. Ryu. *59
Burmeister & Wain Diesel motor, built in America..... *170
Burning of big Pacific coastwise passenger steamship Congress..... 496
Bylayl, launch of collier..... 42

Calculations for ship's forms. Taylor.. *246
Calculations for ship's forms. Taylor.. *71
California Shipbuilding Co..... *146
Canadian government hopper barge No. 2 *53
Canal, the barge..... 436
Canal, completion of Lake Washington.. *417
Cargo capacity in motor ship, gain of. Crowley *400
Cargo handling in American marine terminals, the status of. Rogers..... 356
Cargo steamer Chokyu Maru, bulk. Ryu. *59
Cargo steamer lengthened over 50 feet and converted into an oil tanker..... *420
Castings for American merchant and war vessels. Cone *336
Central Railroad for N. J., new tugs for. Norton *56
Chain cables, power forging of..... 542
Chester Shipbuilding Co..... 128
Chiyo Maru, wreck of the Japanese liner *382
Chokyu Maru, bulk cargo steamer. Ryu *59
City of Portland, auxiliary motor ship. McAlpin *292
Clyde line steamers built on the Lakes.. 321
Coal handling equipment at Pittsburg and Conneaut dock *15
Coal handling on the British waterfront.. .327
Coaling pier at Charleston, S. C., Southern Railway *58
Coastwise collier Jonancy..... *9
Coefficients of vessels. Liddell..... 176
Collier Bylayl, launch of..... 42
Collier Jonancy, coastwise..... *9
Collier No. 1, United States Army..... *184
Colliers Ulysses and Achilles, Panama.. *283
Columbia, trials of motor ship..... 43
Compass, commercial gyroscopic. Sperry 549
Competing marine terminals at seaports. McL. Harding..... *455
Completion of Lake Washington Canal.. *417
Concrete docks, reinforced..... *468
Congestion at marine terminals, costly. Marshall 193
Congress, burning of big Pacific coastwise passenger steamship..... 496
Convention of the American Society of Marine Draftsmen..... 306
Conversion of the army transport McClellan into a refrigerator ship. French *189
Conveying machinery for handling bulk freight on board ship. Greene..... *503
Co-operation between motor trucks and steamship lines in handling freight. Whittemore 61
Corporation formed to study terminal problems 440
Corresponding conditions of steamship service. Liddell..... 225
Corrosion and prevention, Voltaic. Rogers 250
Costly congestion at marine terminals. Marshall 193
Cramp Ship and Engine Building plant. 120
Crandall railway dry docks in Scandanavia *487
Criterion of propeller surface. Doig.... 178
Cubadist, launch of *240

DeLaval high speed, reducing gears, application to turbine drive on board ship *339
Design for turbine-driven ships, propeller. Graveson *66
Design of an oil engine..... 541
Destructive storm damages shipping and waterfront property at Mobile..... *488
Diesel-engined yacht, Georgiana III.... *527
Diesel engine, Werkspoor, Wilson..... *16
Diesel motor, Burmeister & Wain..... *170
Dock, coal handling equipment at Pittsburg and Conneaut..... *15
Dock of Freeport Sulphur Company, loading *447
Docking facilities at New Orleans..... 126
Docks, better for less money. Farrand.. *468
Draft of ships in the Panama canal.... 436

Drafting room. Robinson *11
Dredge with geared turbine-driven pumps *244
Dry docks in Scandanavia, Crandall, railway *487
Dry steam in Scotch boilers—remarkable performance of the steamship Bristol. *205
Dutch passenger and mail steamship. Coleman *181
J. F. Duthie & Co. 148
Economic marine propulsion. Rogers... *316
Economics of a steamship line. Percy.. 398
Economy of handling freight at New York Cetnral Weehawken piers 148
Edward Luckenbach, geared-turbine freight steamship launched at Fore River shipyard *486
Efficient steering. Pratt *207
Electric propulsion on a merchant vessel *13
Electric stevedore, helping the. Yost.... *448
Electricity, how it is harnessed to terminal work. Rogers *464
Elevators, inclined, increase economy of handling freight at New York Central Weehawken piers 148
Engine, future of the marine. Wentworth *270
Engine, Werkspoor marine Diesel. Wilson *16
Engines, Skandia marine oil *220
Estimating, power. Baier *499
Exhaust steam in a shipyard, utility of.. 252
Experiments, inclining—practical hints. Baier 227

Feathering paddle wheels. Bragg 548
Fire-tube superheater on railroad tug, installation of *160
Floating hospital Helen C. Julliard.... *54
Forging of chain cables 542
Friction, theory of fluid. Gatewood.... 544
Fore River shipyard *114
Fore River shipyard, plate and angle shop and mold loft completed *485
Form coefficients of vessels. Liddell.... 176
Freeboard: its preliminary determination. Everett *194
Freeport Sulphur Company, loading dock of *447
Freight, co-operation between motor trucks and steamship lines in handling. Whittemore 61
Freight handling at marine terminals. Marshall 225
Freigth handling at New York Central Weehawken piers 148
Freight handling through unoccupied terminal space. Libby *459
Freight steamer, Milazzo, Italian *365
Freight steamers, new Luckenbach 162
Freight steamship Edward Luckenbach launched at Fore River shipyard *486
Freight terminal problem. Horine *20
Freighters, ocean. Riggs 229
Frozen beef for Europe *273
Fuel values of Alaska coal and marine service. Allison 398
Furnaces installed at Cramp's shipbuilding plant, plate and angle *422
Future of the marine oil engine. Wentworth *270

Gain in cargo capacity in motor ship of about 3,000 tons deadweight capacity. Crowley *400
Geared turbine and turbo-electric systems of marine propulsion. Macalpine *4
Geared turbine-driven dredge pumps.... *244
Geared turbine freight steamship launched at Fore River Shipyard *486
Geared turbine machinery for single screw tank steamer, Westinghouse.... *367
Geared turbine propelling machinery on freight steamer Pacific 159
Geared turbine tank steamer *359
Gearing for ship propulsion, "Alquist." Emmet *536
General C. B. Sears, harbor survey boat. *289
Geometry of wide-bladed screw propeller. Graveson *242
George E. Warren lengthened over 50 feet and converted into an oil tanker.. *420
Georgiana III *527
Gyroscopic compass, commercial. Sperry. 549

Hall Bros'. Shipbuilding and Repair plant *147
Hanlon Dry Dock & Shipbuilding Co., Inc. 142
Hannevig motor-driven oil tankers..... 144
Harbor and port terminal facilities and work. Harding 60
Harbor and waterway improvement work in Russia 436
Harbor survey boat General C. B. Sears. *289
Harlan & Hollingsworth Corporation... *134
Helen C. Julliard, floating hospital..... *54
Helping the electric stevedore. Yost... *448
Hendricks' Commercial Register..... 491
Hoisting equipment for marine terminals *462
Honolulu terminal *446
Hopper barge No. 2, Canadian government *53
Hospital Helen C. Julliard, floating.... *54
How electricity is harnessed to terminal work. Rogers *464
How our navigation laws compare with others 70
Huge plate and angle shop and mold loft completed at Fore River shipyard..... *485
Hunt tracks, tractors and trailers. Jenckes *460

Inclined elevators increase economy of handling freight at New York Central Weehawken piers 148
Inclining experiments—practical hints. Baier 227
Inefficiency in handling imports. Spaulding *437
Institution of Naval Architects, annual meeting of the 239
Italian freighter with special equipment for unloading cargo *365

Jan Pieterszoon Coen, Dutch passenger and mail steamship. Coleman..... *181
Johnson & Lanteri shipbuilding and repair yard *142
Jonancy, coastwise collier *9

Lake Washington Canal, completion of.. *417
Launch of collier Bylayl 42
Launching of the tank steamer Cubadist. *240
Launching, pressure on vessel's bottom during *187
Lloyd's annual report 521
Loading and unloading machines for marine terminals, portable. Frost.... *452
Loading dock of Freeport Sulphur Company, Freeport, Texas *447
Luckenbach freight steamers 162

McClellan, conversion of army transport into a refrigerator ship. French..... *189
Machinery for handling bulk freight on board ship, conveying. Greene..... *503
Manitowoc Shipbuilding & Dry Dock Co. 140
Marine articles in the engineering press 351, 433
Marine oil engines, Skandia *220
Marine propulsion, geared turbine and turbo-electric systems of. Macalpine.. *4
Marine terminal improvements at port of Philadelphia *437
Marine terminal proposed for Honolulu.. *446
Maryland Steel Co 124
Mathis Yacht Building Company 120
Merchant marine, American. Nolan.... 317
Merchant marine, why the Navy League is inetsested in the re-etsablishment of the 482
Merchant shipbuilding in France..... *183
Merrill-Stevens shipyard *127
Milazzo, Italian freight steamer..... *365
Millions of dollars wasted at marine terminals 520
Minnesota, fitted with new boilers..... *493
Model basin, notes from. McEntee..... *530
Modern submarines in war and peace. Lake 29, 75, 201
Moore & Scott shipyard *533
Morse Dry Dock & Repair Co..... *136
Mother ship for the submarines of the U. S. Navy, need of. Skerrett..... *234
Motor-driven oil tankers, Hannevig.... 144
Motor ship, gain of cargo capacity in, of about 3,000 tons deadweight. Crowley. *400
Motor ship City of Portland, auxiliary. McAlpin *292
Motor ship Columbia, trials of..... 43
Motor ship Oregon *335
Motor ship Peru, twin screw 501
Motor ship's five-and-a-half years' service *238
Motor trucks as the solution of the marine freight terminal problem. Horine.... *20
Motor trucks at steamship terminals. Hutchins and Perry *441
Motor trucks for use on steamship piers, advantages. Patten 447
Munamar, Munson steamship *186
Munson steamship Munamar *186

Naval Architects' annual meeting..... 539
Naval Architects' meeting, program of.. 496
Naval experimental wind tunnel at Washington Navy Yard. M'Entee..... *64
Naval preparedness—the British fleet. Sinn 314
Naval stations and naval bases. Niblack. 546
Navigation laws compared 70
Need of an efficient mother ship for the submarines of the United States Navy. Skerrett *234
Nevada, United States battleship..... *155
New and Constructive Policy for Upbuilding the American Merchant Marine. Baker 109
Newport News Shipbuilding & Dry Dock Co. *131
New London Ship & Engine Building Co. *123
New York Shipbuilding Company..... *121
Notes from the model basin. McEntee.. *530

Ocean shipping 8
Ocean freighters. Riggs 229
Oil burning vessels, regulations for..... 288
Oil engine, design of 541
Oil engine, future of the marine. Wentworth *270
Oil tank steamer Antwerpen..... *491
Oregon, motor ship *335
Oil tank steamship Texas *232
Oil tankers, Hannevig, motor-driven.... 144
On the suitability of current design of submarines to the needs of the United States Navy. Rogers 545
S. M. Otis, tug boat equipped with oil engines *231

Pacific, trials of 159
Paddle wheels, feathering. Bragg..... 548
Panama canal, draft of ships in..... 436
Panama colliers Ulysses and Achilles.. *283
Passenger and cargo boat for the West Indies, 64-foot steel *240
Peninsula Shipbuilding Company..... *538
Peru, twin screw motor ship 501
Philadelphia, marine terminal improvements *437
Pitches for screw stays *78
Pittsburg and Conneaut dock, coal handling equipment at *15
Plate and angle heating furnaces Installed at the Cramp's Shipbuilding plant *422
Plate and angle shop and mold loft completed at Fore River shipyard..... *485
Pneumatic tools in shipyards and dry docks. Thor *504
Pocahontas, tug, launched at Norfolk Navy Yard *241

Portable loading and unloading machines for marine terminals. Frost..... *452
Power estimating. Baier..... *499
Power forging of chain cables..... 542
Pressure on a vessel's bottom during launching. Barber *187
Procida, steamship, refrigerating machinery on *273
Profits from old vessels. Woolley..... 224
Progressive American Diesel Engine Building Co *123
Propeller design for turbine-driven ships. Graveson *66
Propulsion, economic. Rogers..... *316
Propeller, geometry of wide-bladeed screw. Graveson *242
Propeller surface, a criterion. Doig.... 178
Propulsion on a merchant vessel, electric *13
Pumps, geared turbine-driven, for dredge *244
Pusey & Jones Shipyard..... *130

Railway dry docks in Scandanavia, Crandall *487
Record year for the Union Iron Works Co *145
Refloating of the Hendonhall. Skerrett.. *26
Refrigerating machinery on S. S. Procida *273
Refrigerator and refrigerator insulation on board ship. Nassa..... 546
Refrigerator ship, conversion of McClellan into. French *189
Regulations for oil burning vessels..... 288
Reinforced concrete docks..... *468
Repair plants and shipyards, United States 113
Repair yards in New York harbor, ship.. *139
Resistance of various types of barges in shallow and deep water. Sadler..... 547
Revival in the United States, shipbuilding 23
River boat tunnel stern *335
Riveting, scientific studies applied to. Kennedy *408
Rivets, rules for ordering. Kennedy.... 529
Robins Dry Dock and Repair Plant..... *137
Rules for ordering rivets. Kennedy.... 529

Salvage experiments used in raising submarine F-4 539
Schooner Annie Johnson, auxiliary. Perkins *407
Scientific studies applied to riveting. Kennedy *408
Scotch boilers—dry steam in—remarkable performance of..... *205
Seattle Construction & Dry Dock Co.... *143
Seattle's steamship terminals. Dohm.... *495
Selected marine patents.. *48, 96, 174, 222, ...268, 312, 354, 396, 434, 480, 518, 560
Shallow draft boats and barges for river navigation. Beach and Kellar..... *53
Shipbuilding activity in Spain..... 142
Shipbuilding and general marine news.... *39, 87, 169, 201, 218, 261, 305, 349, 391, 437, 475, 513, 557
Shipbuilding and Shipping Situation.... 98
Shipbuilding boom, will it last ten years? Aldrich 483
Shipbuilding in France, merchant..... *183
Shipbuilding on the Columbia river..... 315
Shipbuilding on the Kennebec..... 119
Shipbuilding on the Pacific Coast, wooden *403
Shipbuilding revival in the United States 23
Shipping and waterfront property at Mobile, damage by destructive storm.. *488
Shipping Bill, an analysis of. "Old Scotch" 107
Shipping bill submitted to Congress by New York Chamber of Commerce.... 112
Shipping bill, what is to be expected of the. "Old Scotch" 437
Shipping destroyed by war operations.... 121
Shipping, ocean 8
Ship repair yards in New York harbor... *139
Ships built in the United States shipyards *149
Ships, draft of in the Panama canal.... 436
Ship's forms, calculations for. Taylor. *71, 246
Ship stability—The need for investigation. Wall 61
Shipyards and repair plants, United States 113
Shipyard, Skinner & Eddy. Dohm..... *378
Shipyards on the western rivers..... 126
Sinu, American-designed working boat for Cartagena *487
Skandia marine oil engines..... *220
Skinner & Eddy shipyard. Dohm..... *378
F. O. Smith Shipbuilding & Dry Dock Co., Inc. 123
Smoke, method of indicating density of.. 539
Society of Naval Architects, program of. 496
Southern Railway coaling pier at Charleston, S. C..... *58
Spedden Shipbuilding Co..... *127
Stability, the need for investigation, ship. Wall 61
Staten Island Shipbuilding Co..... 122
Status of cargo handling in American marine terminals. Rogers..... 356
Stays, pitches for..... *78
Steamer Chokyu Maru, bulk cargo. Ryu. *59
Steamer Cubadist, launching of the tank steamer *240
Steamer General C. B. Sears..... *289
Steamer George E. Warren, lengthened. *420
Steamer Sucrosa, geared turbine tank.... *359
Steamers built on the Lakes, Clyde line. *321
Steamers, new Luckenbach, freight..... 162
Steamship Antwerpen *491
Steamship Bristol, remarkable performance of—dry steam in Scotch boilers.. *205
Steamship Congress, burning of big Pacific coastwise passenger..... *496
Steamship Edward Luckenbach launched at Fore River shipyard..... *486
Steamship Jan Pieterszoon, Dutch passenger and mail. Coleman..... *181
Steamship line, economics of a. Percy.. 398
Steamship Milazzo..... *365
Steamship Minnesota fitted with new boilers *493
Steamship Munamar, Munson..... *186
Steamship Pacific, trials of..... 159
Steamship Procida, refrigerating machinery on..... *273
Steamship service, corresponding conditions of. Liddell 225
Steamship terminals, motor trucks at. Hutchins and Perry..... *441
Steamship terminals, Seattle. Dohm.... *495
Steamship Texas, oil tank..... *232
Steamship Yuna *321
Steam turbine on board ship..... *339
Steam yacht Winchester..... *329
Steel castings for American merchant and war vessels. Cone..... *336
Steering, efficient. Pratt..... *207
Stevedore, helping the electric. Yost.... *448
Submarine F-4, salvage of..... 539
Submarines in war and peace, modern. Lake..... *29, 75, 201
Submarines of the United States Navy, suitability of current design. Rogers.. 545
Successful installation of fire-tube superheater on a railroad tug..... *160
Sucrosa, geared turbine tank steamer.... *359
Superheater on railroad tug, fire-tube.... *160

Tank steamer Cubadist, launching of the *240
Tank steamer, geared turbine..... *359
Tankers, Hannevig motor-driven oil..... 144
Terminal facilities and work, harbor and port. Harding 60
Terminal improvements at port in Philadelphia *437
Terminal problem, motor truck as solution *20
Terminal problems, corporation formed to study 440
Terminal proposed for Honolulu, marine. 446
Terminal space, freight handling through unoccupied. Libby..... *459
Terminal work, how electricity is harnessed to. Rogers..... *464
Terminals at seaports, competing marine. McL. Harding *455
Terminals, costly congestion at marine. Marshall 193
Terminals, freight handling at marine. Marshall 225
Terminals, hoisting equipment for marine *462
Terminals, motor trucks at steamship. Hutchins and Perry *441
Terminals, portable loading and unloading machines for marine. Frost..... *452
Terminals, Seattle's steamship. Dohm... *495
Terminals, the status of cargo handling in. Rogers 356
Terminals, waste at..... 520
Test of Ward watertube boiler. Robinson *330
Texas, oil tank steamship..... *232
Theory of fluid friction. Gatewood.... 544
Thor pneumatic tools in shipyards and dry docks *504
Toledo Shipbuilding Company..... *133
Trials of geared turbine propelling machinery on freight steamer Pacific..... 159
Trials of motor ship Columbia..... 43
Trials of the steamship Bristol—dry steam in Scotch boilers..... *205
Trucks at steamship terminals, motor. Hutchins and Perry..... *441
Trucks for use on steamship piers, advantages. Patten 447
Trucks, tractors and trailers, Hunt. Jenckes *460
Tug boat S. M. Otis equipped with oil engines *231
Tug Pocahontas, launched at the Norfolk Navy Yard *241
Tugs for Central Railroad of N. J. Norton *56
Tunnel stern river boat..... *335
Turbine and turbo-electric systems of marine propulsion, geared. Macalpine.. *4
Turbine-driven ships, propeller design for. Graveson *66
Turbine machinery for single screw tank steamer, geared. Westinghouse..... *367
Turbine propelling machinery on freight steamer Pacific, trials of geared..... 159
Turbine tank steamer, geared..... *359
Turbo-electric and geared turbine systems of marine propulsion. Macalpine.... *4
Twin screw motor ship Peru..... 501
Twin screw tunnel stern excursion river boat *335
Types of ships built in American yards.. *149

Ulysses and Achilles, Panama colliers.. *283
Union Iron Works Co., record year.... *145
United States army collier built in China. *184
United States battleship Nevada..... *155
United States naval experimental wind tunnel at Washington Navy Yard. McEntee *64
United States, shipbuilding revival in the. 23
Use of conveying machinery for handling bulk freight on board ship. Greene.. *503
Utility of exhaust steam in a shipyard.... 252

Valk & Murdoch Company..... *128
Vessels, profits from old. Woolley..... 224
Voltaic corrosion and prevention. Rogers 250

Ward watertube boiler, test of. Robinson *330
Warships, bids for new..... 482
Watertube boiler, test of Ward. Robinson *330
Werkspoor marine Diesel engine. Wilson *16
Westinghouse geared turbine machinery for single screw tank steamer..... *367
What is to be expected of the shipping bill? "Old Scotch"..... 439
Why the Navy League is interested in the re-establishment of the merchant marine 482

Will the shipbuilding boom last ten years? Aldrich 483
Willamette Iron and Steel Works..... 148
Winchester, steam yacht..... *329
Wind tunnel, U. S. naval experimental at Washington Navy Yard. McEntee.... *64
Wooden shipbuilding on the Pacific Coast *403
World-wide demand for American ships. Taylor 523
Wreck of the Japanese liner Chiyo Maru. *382

Yacht Georgiana III..... *527
Yuna, steamship *321

COMMUNICATIONS

Allen dense air ice machine..... *344, 508
Analyzing a marine steam plant. Percy 209, 254, 298, 386

Boiler efficiency, practical discussion of the effects of combustion space upon.. 471
Boiler room, helpful suggestions for the.. *470
Boiler tubes, leaky..... *385
Boilers, preservation of marine. Rogers. 32

Checking up the coal consumption. Sawyer *79
Circulating engine, emergency repair to.. *388
Classification and filing of engineering data. Walker 295
Coal consumption, checking up. Sawyer. *79
Coaling a liner at Nagasaki. Conover... *79
Combustion space, effect of on boiler efficiency 471
Comparison between pneumatic and electric portable drills and geared hoists. Bassi 424

Data filing system..... *342
Dense air ice machine. Allen..... *344, 508
Deterioration of tail shafts in tropical waters. Conover *383
Direct and indirect valves..... *425, 470
Discharge of feed water in Scotch boiler. Roane 209
Drafting room 253
Dredge troubles 425
Economical method of removing ice from the deck and rigging of a vessel..... 253
Economical repair to worn plunger..... *551
Economy kinks *551
Emergency repair to circulating engine.. *388
Engine, indicator test of triple expansion engine. De Lorma *80
Engineering data, indexing and filing of. Walker 295
Engineering data, indexing and filing. Suzara *383
Engineer's kit of tools, marine..... 31
Expensive error of judgment..... 297

Feed heaters for small boats..... *297
Feed pump valves. Haas..... 509
Feed pumps and methods used to overhaul them. Wolf *255
Feed water discharge in Scotch boiler.... 163
Feed water heating. Rogers..... 507

Gasket kink 470
Graphic record of poor header seats in sectional type boilers..... *298
Graphical determination of particulars for spiral springs *163
Geared hoists and pneumatic and electric portable drills, comparison between. Bassi 424

Handy kink. Sawyer..... 209
Header seats in sectional type boilers, graphic method of..... *298
Helpful suggestions for the boiler room.. *470
Heaters, feed, for small boats..... *297
Heating feed water. Rogers..... 507
How feed water should be discharged into a Scotch boiler. Roane..... 209
Hydrostatic test pressure..... 341

Ice machine, Allen dense air..... *344, 508
Ice, removal from rigging of vessels.... 253
In what part of a Scotch boiler should the feed water be discharged?..... 163
Indexing and filing engineering data. Suzara *383
Indicator test of triple expansion marine engine. De Lorma..... *80

Kinks, some economy..... *551
Kink, gasket 470

Laurenti submarines. C. Laurenti..... 253
Leaky boiler tubes..... *385
Lubricating bearings. Forbes..... 343

Main bearings, refitting..... *383
Marine boilers, the preservation of. Rogers 32
Marine engineer's kit of tools..... 31
Marine steam plant, analyzing a. Percy. 298
Method of removing ice from the deck and rigging of a vessel..... 253

Naval architecture, reference library of. Christmas *295

Opportunity for export of American machinery and supplies to Russia..... 82
Overhauling feed pumps..... *255

Piston, removing from its rod..... 82
Pneumatic and electrical portable drills and geared hoists, comparison between. Bassi 424
Practical discussion of the effects of combustion space upon boiler efficiency.... 471
Preservation of marine boilers. Rogers.. 32
Pump linings, renewing wornout..... 424
Pump plunger, repairs to..... *551

Reference library of naval architecture. Christmas *295
Refitting main bearings..... *383
Removing a piston from its rod..... 82
Renewing wornout pump linings..... 424
Repairs to a defective tube..... 31
Reairs to worn plunger..... *551

Should the hydrostatic test pressure of one and one-half times the working pressure be applied to marine steam boilers annually?..... 341
Some economy kinks..... *551
Safety valves, setting and care..... *554
Spiral springs, graphical determination of particulars for *163
Statical stability at small angles. Doig.. *165
Steam plant, analyzing a marine. Percy 209, 254, 386
Stop valves 553
Submarines, Laurenti. C. Laurenti..... 253

Tail shafts, deterioration of in tropical waters. Conover .....
Tools, marine engineer's kit..... 31
Triple expansion engine, indicator tests of 80
Tube, repairs to a defective..... 31
Tubes, leaky boiler..... *385

Valves, direct and indirect..... *425, 470
Valves, feed pump. Haas..... 509
Valves, stop 553

EDITORIALS

Address, change of 223
American classification gaining recognition 313
American shipbuilders, prosperity for.... 1
American shipping's great opportunity.... 313
Analyzing a marine steam plant..... 223
Antiquated terminals must go..... 435
Auxiliary sailing vessels..... 3

Barge canal 436
Battleship construction, cost of..... 3
Bids for new warships..... 482
Bulkhead and load lines committee..... 481

Change of address..... 223
Classification and filing of engineering data 175
Classification gaining recognition, American 313
Coast guard service, cutters needed for.. 3
Cost of battleship construction..... 3
Cost of freight handling, who pays..... 435
Cost, repair of motor ships..... 51
Cutters needed for Coast Guard Service 3

Data, classification and filing of..... 175
Deutschland, forerunner of the..... 397

Economical river transportation..... 269
Effect of war on shipbuilding..... 397
Excursion steamers, fireproof..... 2
Experimental laboratory, naval..... 49

Fire protection on steamers..... 269
Fix the responsibility..... 175
Forerunner of the Deutschland..... 397
Freight handling, who pays the high cost of? 435
Future needs of shipping..... 481

Geared turbine-driven tank ships..... 355
Geared turbines..... 1
Geared turbines for destroyers, Navy Department adopts 397
Government vs. private ownership..... 1

Japanese shipbuilding and shipping..... 2

Load Lines and Bulkhead Committee.... 481

Marine steam plant, analyzing a..... 223
Merchant marine, training of officers for 223
Merchant submarines 355
Motor ships, repair costs of..... 51

Naval Architects' meeting..... 481
Naval experimental laboratory..... 49
Naval training for civilians..... 269
Navy Department adopts geared turbines for destroyers 397

Officers for merchant marine, training of 223

Port, the world's greatest..... 435
Private ownership vs. government..... 1
Progress of American shipbuilding..... 397
Prosperity for American shipbuilders.... 1
Repair costs of motor ships..... 51
Revival of wooden shipbuilding..... 313
River transportation, economical..... 269

Sailing vessels, auxiliary..... 3
Ship stability 49
Shipbuilders, prosperity for American... 1
Shipbuilding, effect of war on..... 397
Shipbuilding outlook 355
Shipbuilding, progress of American..... 397
Shipbuilding, revival of wooden..... 313
Shipbuilding situation..... 97
Shipping and shipbuilding, Japanese.... 2
Shipping bill 269
Shipping's greatest opportunity..... 313
Shipping, future needs of..... 481
Stability, ship 49
Standardized ships..... 269
Status of the submarine..... 175
Steam plant, analyzing a marine..... 223
Steamers, fireproof excursion..... 2
Steamship terminal improvement..... 50
Submarine, submergence test of a..... 176
Submarine, status of..... 175
Submarines, merchant 355

Terminal improvement, steamship..... 50
Terminals, antiquated must go..... 435
Test of the submarine, submerged..... 176
Training of officers for the merchant marine 223
Turbines, geared 1

Vessels, auxiliary sailing..... 3

Warships, bids for new..... 482
What are the facts?..... 435

Who pays the high cost of freight handling? ... 435
Who will build the ships? ... 397
Why shoot mosquitoes? ... 49
World's greatest port ... 435

ENGINEERING SPECIALTIES

Air pump, Radojet. C. H. Wheeler Mfg. Co ... *516

Berths, metal. Bernstein Mfg. Co ... *266
Boilers. Babcock & Wilcox ... 46
Boring bar, "Gauge-All" expansible double. Vislok, Ltd ... *94

Circulators. Eckliff Automatic Boiler Circulator Co ... *92
Compressor, turbine-driven. DeLaval Steam Turbine Co ... *92

Davit turning gear. Coston Signal Co ... *308

Engine, 120-horsepower 4-cylinder Nlseco Diesel. New London Ship & Engine Co. *44

Fire helmet. Maxwell-Hood Manufacturing & Selling Co ... *353
Flanging press, standard 200-ton sectional. Southwark Foundry & Machine Co ... *309
Flue welder, "Universal." Southwark Foundry & Machine Co ... *558

Generator, bipolar oxygen and hydrogen. International Oxygen Company ... *308
Gratings for engine-room platform "Subway." Irving Iron Works Co ... *265

Hoist, new model "Little Tugger." Hydraulic bolt forcer, 40-ton. Hydraulic Ingersoll-Rand Co ... *515
Press Mfg. Co ... *266
Hydraulic steering gear. American Engineering Co ... *352

Lubricating box for propeller shafts. F. R. Cedervall & Soner ... *94

Metal sawing machine "Q. M. S." ... *352
Motor lifeboats. Welin Marine Equipment Co. ... *220

Oil engine, "Skandia." Marine Oil Engine Co., Inc ... *220
Oxy-acetylene cutting torch. Imperial Brass Co ... *44
Ozonators, electric, for cold storage spaces. Sprague Electric Works ... *266

Piling, straight web steel sheet. Lackawanna Steel Co ... *352
Plate planer. Covington Machine Co ... *310
Portable pneumatic drill for exceptionally heavy work. Ingersoll-Rand Co ... *264
Projector, flood-lightning. General Electric Co ... *95
Pump, "Viking" rotary. Schirmer-Frensdorf Co ... *93
Pumps, centrifugal. Wheeler Condenser & Engineering Co ... *310
Punch, portable channel iron. W. A. Whitney Mfg. Co ... *94
Punches. Covington Machine Co ... *264

Shovel, power scraper. Brown Hoisting Machinery Co ... *45
Stove, "Speedway" alcohol, for yachtsmen. Gas Engine & Power Co. and Chas. L. Seabury & Co., Cons ... *265

Torch, savings made by oxy-acetylene cutting. Imperial Brass Mfg. Co ... *44
Turbo gear installation. Turbo Gear Co. . *220

Valve, "Everlasting" blow-off. Scully Steel & Iron Co ... *93

Whistle control. McNab Co ... *479

MARINE ARTICLES IN THE ENGINEERING PRESS

Apprenticeship. Education of youths before and after their. Mundella ... 260

Bingera, turbine machinery of the steamship ... 217
Breifond and Aztec, cylindrical tank oil-carrying steamers ... 85

Canadian railway ferry steamer Scotia II 86
Coast Guard Ossipee and Tallapoosa, trials of ... 35
Composition of the exhaust from liquid fuel engines. Fenning ... 303
Cruiser sterns on merchant ships ... 304
Cushing, trials U. S. torpedo boat destroyer. Cox ... 260
Cylindrical tank oil-carrying steamers Breifond and Aztec ... 85

Description and trials of the U. S. torpedo boat destroyer Cushing. Cox ... 260
Designs of propelling machinery for a 19½-knot steamer, some alternative. Dornan ... 86
Destroyer Wadsworth, U. S. ... 36
Determination of the principal dimensions of marine reciprocating propelling machinery ... 304
Dock of 14,000 tons lifting power at Rotterdam, floating ... 260

Education of youths before and during their apprenticeship. Mundella ... 260
Ericcson, torpedo boat destroyer. Lange. 85

F-4, salvage of the submarine. Furer ... 35
Fastenings, steam turbine blade. Capstaff 304
Ferry steamer Scotia II, Canadian railway ... 86
Floating dock of 14,000 tons lifting power at Rotterdam ... 260

Geared turbine propelling machinery of the S. S. Northumberland ... 303

Heat losses in steam transmission. Cathcart ... 85
History of Lloyds. Marsden ... 304

Improvement of screw steering gear ... 85

Jean Pieterszoon Coen, twin screw steamer ... 35

Kangaroo, Western Australian government ... 86

Lighting of a passenger steamer. Spaulding ... 303
Lighting of ships. Horner ... 303
Lloyds, history of. Marsden ... 304
Lubrication, practical. Bryan ... 260

Marine reciprocating propelling machinery, determination of the principal dimensions of ... 304
Merchant marine from a Southerner's viewpoint ... 38
Method of estimating the stability required by a ship. Liddell ... 85
Motor-ship Kangaroo, Western Australian government ... 86
Mystery of the screw propeller. Dyson ... 217

Northumberland, geared turbine propelling machinery of ... 303
Novocastrian, passenger and cargo steamer ... 303

Oil-carrying steamers Breifond and Aztec 85
Ossipee and Tallapoosa, trials of Coast Guard ... 35

Passenger and cargo steamer Novocastrian ... 303
Practical lubrication. Bryan ... 260
Principal dimensions of marine reciprocating propelling machinery, determination of the ... 304
Propeller tests, experimental basin, German government, Berlin ... 35
Propeller, the mystery of the screw. Dyson ... 217

Railway ferry steamer Scotia II, Canadian ... 86
Reciprocating propelling machinery, determination of the principal dimensions of marine ... 304

Salvage of the submarine F-4. Furer ... 35
Scotia II, Canadian railway ferry steamer 86
Screw propeller. Denny ... 303
Screw propeller, the mystery of. Dyson. 217
Screw steering gear, improvement of ... 85
Shipbuilding in 1915, the world's, excluding warships ... 216
Ship calculations, time element and related matters in some. Welch ... 216
Some alternative designs of propelling machinery for a 19¼-knot steamer. Dornan ... 86
Stability curves, standardization of. Ayre. 216
Stability required by a ship, method of estimating. Liddell ... 85
Standardization of stability curves. Ayre 216
Steamer Jean Pieterszoon Coen, twin screw ... 35
Steamer Novocastrian, passenger and cargo ... 303
Steamer Scotia II, Canadian railway ferry ... 86
Steamers Breifond and Aztec, oil-carrying ... 85
Steamship Bingera, turbine machinery of the ... 217
Steamship Northumberland, geared turbine propelling machinery of ... 303
Steam transmission, heat losses in. Cathcart ... 85
Steam turbine blade fastenings. Capstaff. 304
Submarine F-4, salvage of the. Furer ... 35
Systematic propeller tests, experimental basin, German government, Berlin .. 35

Tallapoosa and Ossipee, trials of Coast Guard ... 35
Tests, propeller, German government ... 35
Time element and related matters in some ship calculations. Welch ... 216
Torpedo boat destroyer Cushing, trial and description of. Cox ... 260
Torpedo boat destroyer Ericcson. Lange. 85
Torpedo, the ... 35
Trials and description of the U. S. torpedo boat destroyer Cushing. Cox ... 260
Trials of Coast Guard Ossipee and Tallapoosa ... 35
Turbine machinery of the steamship Bingera ... 217
Twin screw steamer Jean Pieterszoon Coen ... 35

U. S. torpedo boat destroyer Cushing, trial of. Cox ... 260
United States Ship Wadsworth ... 36

Volatile matter of coal. O'Neill ... 304

Wadsworth, U. S. S ... 36
Western Australian Government Motor-Ship Kangaroo ... 86
World's shipbuilding in 1915 (excluding warships) ... 216

PARAGRAPHS

Annual meeting of Institution of Naval Architects ... 117
Annual Motor Boat Show ... 12
Argentine battleships accepted ... 168

Boilers, care of ... 192
British Columbia to aid shipbuilders ... 311

Cadetship in the United States Coast Guard ... 256

Cast iron for high speed engine cylinders 260
Coal handling at Mobile Harbor 415
Connecticut river improvement 19
Correction 148, 264

Danish ships of 1776 pressed into service 311
Diesel engine excursion boat 381
Difficult repair job at sea 335
Ductility of bars for stays and braces in marine boilers 294

German ships interned in United States ports 245

Important development in life saving equipment 251
Institution of Naval Architects, annual meeting of 117
Isherwood-framed ships building in the United States 494

Japanese line buys former Pacific Mail steamers 310
Japanese shipyard, year's record 353

Lake Erie ore dock to be enlarged 300
Lake seamen's wages raised 426
Large motor ship building in Seattle 415
Largest plate mill in the world 70
Launch of Lake oil tanker 82
Launch of steamship Edgar F. Luckenbach 241
Launch of the S. S. Paris 472
Launch of the United States dock Wando 221
Launches, recent 179
Lightship launched No. 101 58
Loss of lake steamer S. R. Kirby 300
Losses in merchant shipping 388
Losses to merchant shipping 353

Marked increase in Japanese shipping to the United States 177
Memorial to Sir William White 415
Men of the American merchant marine. 217
Merchant shipping 288
Motor ship building in Seattle 415

Neuritania ready, giant liner 425
Naval Architects' annual meeting 428
New battle cruisers 506
New giant liner ready 425
New organization, Marine Engineers' Beneficial Association, Ocean, No. 99. 401
New Swedish shipyard 19

Obituary 46, 95, 221, 267, 311, 351, 395, 433
Officers of the National Board of Steam Navigation 19

Personal 47, 95, 221, 267, 311, 351, 395, 433, 475
Power barge service between Philadelphia and New York 335

Railroads to retain steamship lines 300
Reinforced concrete dock at Houston, Texas 300
Reopening of the Panama canal 302

Sale of Chilean ships to be prohibited 388
Sale of Danish vessels prohibited 58
Shipbuilding boom in China 84
Shipbuilding reports 433, 494
Shipbuilding returns, Lloyd's quarterly 239, 433, 494
Shipbuilding returns, monthly 458
Shipyards' improvements 213
Standard Shipbuilding Corporation 117
Survey of New Jersey ship canal 86
Sweden prohibits sale of vessels 19

Tramp steamers of Japan 302
Trials of battleship Pennsylvania 189
Two hundredth anniversary of Boston Light 510

United States colliers to be fitted with Diesel engines 294

Vessels built in United States 65
Vessels built in the United States in January 133

QUESTIONS AND ANSWERS

Absorption of water by gas 511
Aeroplane propellers 555
Ahead and backing power of engine 428
Air pump, discharge temperature of 427
Ammonia and compression refrigerating systems compared *347
Amount of material necessary to sheath a boat *347
Analyses of stresses *473
Application of the theory of mechanical similitude 214
Area of rudders 214
Auxiliaries, steam consumption of *302

Backing and ahead power of engine 428
Bearings, connecting rod 214
Best method of reducing power 214
Boiler horsepower and engine horsepower 35
Boiler tubes, effect of soot on 35
Boilers, laying up 512
Books on marine engine design 556
Books on propeller design 167
Books on wooden shipbuilding 512
Brushes, remedies for sparking of 214

Calorific value of coal 168
Calorific values of fuel gases 35
Calorific values of gasoline and kerosene, Relative 167
Classification of Terry turbine 389
Coal, calorific value of 168
Coefficients, hull, length and breadth to be used for 214
Coefficients of friction of lubricating oils 36
Coils in spring, number of *84
Cold storage compartments, insulating materials for 389
Comparison of engine performance 390
Compressed city gas, volume of 168
Compression and absorption of ammonia, refrigerated systems compared *347
Connecting rod bearings 214
Consumption of lubricating oil for gasoline (petrol) engine 167
Consumption of steam, direct acting Simplex feed pump 257
Consumption of steam for feed pump 390
Consumption of steam of auxiliaries *302
Costs, labor 555

Defects in indicator cards *511
Definition of "Inverted" as applied to marine engines 348
Difference between compression and absorption ammonia refrigerating systems *347
Dimensions of propeller, formula for 36
Direct and indirect valves 389

Effect of throttling of superheated steam 512
Effect of soot on boiler tubes 35
Effect on steam consumption of throttling dry steam 301
Efficiency of radial and feathering wheels *474
Electric wiring 428
Energy and heat 555
Engine design, books on 556
Engine horsepower and boiler horsepower 35
Engine, method of testing a gasoline *83
Engine performance, comparison of 390
Equalizer leads, size of 389
Evaporation of Scotch and watertube boilers 390
Evaporator plant, feed heater for *427
Expansion of steam, rule for 257

Feathering and radial wheels, efficiency of *474
Feed heater for evaporator plant *427
Feed pump, steam consumption of 257
Feed pump, trouble with 389
Flue gases, percentage of CO_2 in, for good operation *84
Formula for dimensions of propeller 36
Friction of lubricating oils, coefficients of 36
Fuel gases, calorific values of 35

Gases, calorific values of fuel 35
Gearing, marine reduction 427

Hatchet planimeter 257
Heat and mechanical energy 555
Highest steam pressure recorded—velocity of flow of steam 83
Horsepower, boiler and engine 35
Horsepower in stern-wheel river boats in upstream and down stream runs 168
How to figure horsepower of Janney-Williams motor 167
Hull coefficiencies, length and breadth to be used for 214

Impulse turbines, multi-stage 301
Increasing voltage of generator set 389
Indicator cards, defects in *511
Indicator cards for triple expansion engine *348
Insulating materials for cold storage compartmetns 389
Inverted marine engine, definition of 348

Janney-Williams motor, horsepower of 167

Kingsbury and Michel thrust bearings *257

Laying up boilers 512
Length and breadth to be used for hull coefficients 215
Ljungstrom turbine 390
Low pressure piston rods, size of 215
Lubricant for use in cutting threads in mild steel bolts 259
Lubricating oil for gasoline (petrol) engine, consumption of 167
Lubricating oils, coefficients of friction of 36

Marine reduction gears 427
Masts, rake of 555
Mechanical energy and heat 555
Mechanical similitude, application and theory of 214
Metacentric height *555
Method for finding power of a number 427
Method of testing a gasoline (petrol) engine *83
Michell and Kingsbury thrust bearings *257
Motors, overheating of enclosed 259
Multi-stage impulse turbines 301

Number of "live" or effective coils in a spring *84

Oils, coefficients of friction of lubricating 36
Operation of Westinghouse refrigerating machine 214
Overheating of enclosed motors 259
Paddle wheels, radial and feathering, efficiency of *474
Percentage of CO_2 in flue gases for good operation 84
Piston rods, areas of low pressure 215
Planimeter, hatchet 257
Power for driving propeller 512
Power reduction, methods of 214
Propeller design, books on 167
Propeller for motor boat, size of 389
Propeller, formula for dimensions of 36
Propeller, power for driving 512
Propellers, aeroplane 555
Pump, test of 427

Radial and feathering wheels, efficiency of *474
Rake of masts 555
Rate of evaporation for Scotch and watertube boilers 390
Ratio of turbine reduction gearing 390
Reduction gearing, ratio of 390
Reduction gears, marine 427
Refrigerating machine, Westinghouse, operation of 214
Refrigerating sytsems, difference between compression and absorption ammonia *347
Relative calorific values of gasoline (petrol) and kerosene (paraffin) 167
Remedies for sparking of brushes 214

Riveting on oil tank vessels..... 301
Rudders, area of 214
Rule for expansion of steam..... 257

Schools of naval architecture and marine engineering 214
Searchlight, size of..... 427
Self-trimming vessels *35
Sheathing of boat, material necessary.... *347
Size of equalizer leads..... 389
Size of low-pressure piston rods..... 215
Size of propeller for motor boat..... 389
Size of searchlight..... 427
Soot on boiler tubes, effect of..... 35
Sparking of brushes, remedies for..... 214
Steam consumption of auxiliaries..... *302
Steam consumption of direct acting simplex feed pump 257
Steam consumption of feed pump..... 390
Steam, rule for expansion of..... 257
Steam velocities for short stroke high speed marine engines..... 301
Stern wheel river boats, horsepower of.. 168
Stresses, analyses of..... *473
Superheated steam, effect of throttling of. 512

Theory of mechanical similitude, application of 214
Temperature of an air pump discharge.. 427
Terry turbine, classification of..... 389
Test for steam consumption of feed pump 390
Test of steam pump..... 427
Testing a gasolene engine, method of... *83
Throttling of superheated steam, effect of 512
Thrust bearings, Michel and Kingsbury. *257
Trouble with feed pump..... 389
Tubes, effect of soot on boiler..... 35
Turbine, Ljungstrom 390
Turbine reduction gear, ratio of..... 390
Turbines, multi-stage impulse..... 301
Turbines on Vaterland and Imperator... 167
Turning moment of propeller shaft, variation of 389
Type of turbines on the Vaterland and Imperator 167

Unbalanced forces in twin screw engines *555

Values of fuel on gases, calorific..... 35
Valves, direct and indirect..... 389
Variation of turning moment in propeller shaft 389
Vessels, self-trimming *35
Viscosity scales 259
Voltage of generator set, increasing of.. 389
Volume of compressed city gas for a tank 168

Weight of aeroplane and automobile engines 427
Westinghouse refrigerating machine, operation of 214
Wheels, radial and feathering, efficiency of *474
Wiring, electric 428
Wooden shipbuilding, books on..... 512

TECHNICAL PUBLICATIONS

Design of Steam Boilers and Pressure Vessels. Haven and Swett..... 84
Diesel Designs: Marine and Stationary. Goldingham 36

How to Save a Big Ship from Sinking. Eley 84

Johnson's Steam Vessels of the Atlantic Coast 215

Land and Marine Diesel Engines. Supino 506

Marine Steam Turbine. Sothern..... 506
Mechanical Engineers' Handbook..... 428
Mechanical Engineers' Pocketbook. Kent 215

Sailing Ships and Their Story. Chatterton 36
Story of the American Merchant Marine. Spears 36

The Mechanical Handling and Storing of Materials. Zimmer..... 550
The Naval Architects' Shipbuilder's and Marine Engineer's Pocketbook. Mackrow and Woollard 428
Trade as a Science. Benn..... 550

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Prosperity for American Shipbuilders

Never before in this generation has a new year begun with brighter prospects for the shipbuilders in the United States. Over 200 merchant vessels, totaling about 700,000 gross tons, are now under construction in American shipyards, and the number of inquiries out for new tonnage, not only from shipowners in the United States, but also from foreign shipowners, give every indication that the present boom in shipbuilding will last for several years. Most of this tonnage is in the form of large seagoing vessels, suitable for foreign trade and eminently fitted for service as naval auxiliaries. About one-half of the tonnage of large seagoing vessels consists of oil tankers. The majority of the remainder consists of colliers or general freight-carrying steamships, although six large passenger and freight steamships are also under construction. On account of the havoc wrought by the European war on the shipping and shipbuilding industries of the belligerent nations, not only has the scarcity of tonnage caused an unprecedented demand for American-built ships, but the resulting market conditions have made the prices for new tonnage wholly favorable to American shipbuilders.

Government vs. Private Ownership

One of the main reasons put forth by the Administration at Washington for presenting to Congress a bill for Government ownership of vessels has been that private capital would not invest in ships for service in the foreign trade. This argument may have had slight force when it was first presented, but it has been a great mistake on the part of the Administration and its friends to continue arguing along these lines.

We have records in our office of over 90 seagoing steamships under contract in shipyards on the Atlantic coast, representing an investment of more than $75,000,000 (£15,350,000). These figures do not include a large number of contracts for smaller craft that could not be classified as seagoing vessels, which represent many millions of dollars, nor do they include contracts for a considerable number of seagoing vessels that have been placed in shipyards on the Pacific coast. Eight or ten large vessels are under construction on the Great Lakes, but naturally they are for service only on the lakes. Also the several Welland Canal-size vessels under construction on the Great Lakes are for coastwise service only.

Outside of the smaller vessels under construction on the seacoasts and on the lakes, it is safe to say that nearly $100,000,000 (£20,500,000) is represented by contracts already placed for seagoing vessels in this country, and that the number is well over 100. The proposition of the Administration, therefore, to have the Government spend $50,000,000 (£10,250,000) in purchasing ships for service in the foreign trade will accomplish only a small part of what is already being done by private capital, especially as there would be other expenses besides the mere purchasing of ships.

Geared Turbines

An interesting discussion of the subject of geared turbines and turbo-electric systems of propulsion is contributed to this issue by Mr. John H. Macalpine, who with the late Rear Admiral George W. Melville, former engineer in chief of the United States Navy, invented the floating frame reduction gear now manufactured by the Westinghouse Machine Company. This discussion is called forth by the recent successful trials of the United States collier *Neptune*, on which the first Westinghouse geared turbine machinery was installed.

The *Neptune* exceeded her contract speed of 14 knots by more than a quarter of a knot and her coal consumption was fully 15 percent within her guaranteed consumption. Recent developments of the Westinghouse geared turbine machinery, however, lead to the belief that far greater economies will be obtained with this form of propulsion, not only at full power, but also at reduced speeds. Geared turbine installations are now being built for two foreign warships of 22,000 horsepower each in which a water rate of the turbines at full power of 10.8 pounds per shaft horsepower per hour is guaranteed and a rate of 10.5 pounds at from 80 to 85 percent of full power. At quarter load the guaranteed water rate is only 11.5 pounds, or 6.5 percent, above the full power rate.

This result is to be accomplished by the use of what the Westinghouse Company has called a divided flow turbine applied to reduction gears. In this system, as explained in Mr. Macalpine's paper, the high-pressure turbine is of the impulse reaction type in which an astern

turbine of 60 percent of the full ahead power is incorporated. The low-pressure turbine is of the Westinghouse reaction double flow type. Both the high- and low-pressure turbines are geared to the same shaft. All of the steam is admitted through groups of nozzles to the high-pressure impulse wheel, after which at full load one-third of the steam is expanded through the reaction blading of the high-pressure element, while the remaining two-thirds passes to the low-pressure turbine. At cruising speed the low-pressure turbine is shut off entirely and the small high-pressure turbine of only one-third the capacity of the entire unit is in operation at its full rating.

The possibilities of such geared turbine arrangements on single or multiple shaft installations with a view to economical operation at various speeds and savings in weight and space are obvious. That the geared turbine is far beyond the experimental stage and is steadily gaining favor among shipowners and marine engineers is evidenced by the fact that several thousand horsepower are built or building, not only for naval work, but also for merchant vessels.

Fireproof Excursion Steamers

Ever since the burning of the *General Slocum* the Supervising Inspector-General of the United States Steamboat Service has repeatedly urged that excursion steamers be constructed of fireproof materials. This recommendation is again made in the annual report of the Secretary of Commerce, who asks for the enactment of legislation "to provide that on and after January 1, 1918, excursion steamers carrying 250 passengers or more shall be constructed of strictly fireproof materials."

The question of fireproof construction of vessels has been discussed at length a number of times in recent years at meetings of the Society of Naval Architects and Marine Engineers. In 1906 Mr. William Gatewood, naval architect of the Newport News Shipbuilding & Dry Dock Company, described an adaptation of fireproof construction to the building of the *Jamestown,* an excursion steamer 262 feet long, 38 feet molded beam, and 14 feet 6 inches molded depth, for service on the Potomac River. This vessel was built of strictly fireproof materials, and, as compared with a similar vessel of ordinary construction, involved an increase of both weight and cost of about 10 percent. At the same meeting a fireproof ferryboat of 625 tons displacement, built for use between Philadelphia, Pa., and Camden, N. J., was described by Mr. F. L. DuBosque. In this vessel the increased cost was about 7 percent and the increased weight about 5 percent. At a later meeting of the Society in 1912 a proposed design of an electrically propelled fireproof excursion steamer was described by Mr. William T. Donnelly, and, although the weight and cost of the vessel were materially increased over those for an ordinary excursion steamer, nevertheless it was estimated that the increased economy of the propulsive machinery and the use of the power plant for commercial purposes in the winter months would more than offset the increased cost.

The discussion of these papers centered mainly on the use of all-steel construction for fireproof vessels, and the opinions expressed may be summed up in the statement that except in special cases the use of steel for the construction of a strictly fireproof vessel is likely to be impracticable, if not impossible. In excursion steamers for day service only, with open decks and a minimum amount of divisional bulkheads (largely of glass) on the upper decks, the use of steel or other strictly fireproof materials is undoubtedly feasible. The weight and cost will be greater, but not prohibitive. The problem is similar to that involved in the case of the *Jamestown* or the ferryboat referred to above. In the case of vessels with large superstructures above the main deck, however, such as the night boats on the Hudson River or Long Island Sound, the difficulties of fireproof construction encountered, such as the discomfort to passengers and crew from heat in the summer in structures entirely of steel, the objectionable springiness of light steel decks and the additional weight and cost of steel upper works are very likely to be found prohibitive. When the *Plymouth,* of the Fall River Line, was burned in March, 1916, the question of rebuilding the vessel entirely of steel was carefully investigated, but the increased weight was found prohibitive for this class of vessel. As a solution of the problem various means of retarding and preventing fires were adopted, such as partial steel construction, fire bulkheads and a complete automatic-sprinkler system; but, above all else, chief reliance was placed on a highly disciplined fire patrol or watch by the officers and crew of the vessel, which has proved extremely effective on this, as well as other, first-class steamship lines.

In view of the experience brought out in the discussion of this subject, the use of strictly fireproof materials in vessel construction should not be made compulsory until the type and service of the vessel for which such construction is intended are clearly defined, as well as the classes of materials that will be accepted as "strictly fireproof." Other fireproof materials, lighter than steel, must enter largely into such construction if the term "excursion steamer" is to apply to all vessels used for excursion purposes.

Japanese Shipbuilding and Shipping

Reports from Japan show that in the various Japanese shipyards sixty-five seagoing steamships of about 290,000 tons are now under construction for Japanese and foreign firms. In 1915 eight vessels of about 53,000 tons have been built, while most of the others now under construction will probably be completed in 1916.

This activity in the Japanese shipyards is the direct result of the policy of the Japanese Government in fostering its shipping. Aside from the regular subsidized Japanese steamship lines running to America, Australia, China and Russia, the greatest activity of Japanese shipping interests

is to be found in the increasing use of tramp steamers in foreign trade. The tramp steamers belonging to the Japan Ship Owners' Union number about 240, exclusive of vessels whose tonnage does not exceed 500 tons, and most of them are owned by individuals. Of this number, 41 vessels are chartered by the large subsidized steamship companies; twenty are engaged in regular ocean voyages under the management of individual shipping firms; sixty-seven are engaged in coastwise service, and fourteen large steamers are chartered by foreign firms. About eighty-two large steamers, whose tonnage is over 3,000 tons, are engaged in over-seas trade; ten on the Australian line; ten on the American line; twenty-three on the South Seas, Indian and Australian lines; eighteen on the Manchuria and Vladivostok line, and twenty-one on the Chinese coast line. In addition, about fifty-five large vessels are chartered out to firms engaged in foreign trade.

Needless to say, this remarkable progress in Japanese shipping and shipbuilding is bringing Japan into an enviable position in the control of trade on the Pacific Ocean.

New Cutters Needed for the Coast Guard Service

In view of the splendid service which has been rendered by the Coast Guard Service in saving lives and floating property and removing menaces to navigation from the seas, no mistaken policy of false economy should deter Congress from meeting the urgent needs of this service in the matter of appropriations for supplying such vessels as are needed to maintain the service efficiently.

As a matter of fact, several additions to the Coast Guard fleet are badly needed at the present time. The cutters *Perry* and *Tahoma* have been sunk on Alaskan reefs and two new cruising cutters are needed to replace these vessels. In New York harbor there is a tug-boat that is forty-two years old, and in San Francisco harbor there is another boat that is forty years old which is in a wornout condition. These should be replaced by modern, up-to-date craft, and for this purpose three harbor cutters are asked for. In addition, three light-draft river cutters are needed for use on inland waters.

Considering the fact that in the last ten years the construction or purchase of only eleven cutters has been authorized by Congress, and also that of the present fleet ten vessels are more than twenty years old, and three of these more than thirty-five years old, there can be little excuse for failing to meet the requirements of this most important service.

Auxiliary Sailing Vessels

Questions regarding the economy of auxiliary sailing vessels can be answered satisfactorily only by data from the actual service of such vessels. A three-masted fore-and-aft schooner with a loading capacity of 370 tons, fitted with a 120-horsepower reversible crude-oil engine, has been running for more than a year. The economical speed of this vessel has been determined as 8 knots. With a favorable wind the vessel is run under sail power alone, otherwise the auxiliary engine is run with the power necessary to maintain a speed of 8 knots. In a period of 100 days the auxiliary engine on this vessel worked 700 hours with a gross fuel consumption of 17 tons of oil, which figures out as .404 pound of oil per horsepower-hour. Although a higher speed might be obtained by supplying additional power to a boat of this type, nevertheless experience has shown that when the speed was increased above 8 knots the power required was out of proportion to the increase of speed and the resulting benefits. As compared with a sailing vessel, the cost of operation of an auxiliary sailing vessel is, roughly, 40 percent higher. The increased earnings of the auxiliary sailing vessel, however, due to the greater number of voyages possible and the less time required in port for loading and unloading, is something like 140 percent, so that the net surplus in favor of the auxiliary sailing vessel is well worth while when continual employment is found for the vessel.

Cost of Battleship Construction

If it were possible to compare the bids of private shipbuilders for the latest United States battleships with the estimates prepared by navy yards, item for item, it would be found that the figures of the private shipbuilders were in a reality lower than those of the navy yards. Such a comparison, however, as we have pointed out before, is difficult to make, for, while both sets of figures represent the cost to the United States of the same ships, they do not cover the same incidental expenses. In other words, items which private shipbuilders must pay for as a part of the cost of construction are not included in the estimates of the cost of construction by the navy yards:

A few of these items are as follows:

The cost of drawings and plans, which in the navy yards come under a special appropriation.

Salaries of clerks, timekeepers and other minor officials, which in navy yards come out of a general expense account.

Insurance and indemnity bonds, not carried on work in navy yards.

Trial trips of the vessel, not included in the navy yards' estimates, as the trials of Government-built vessels are carried out after the vessels are in service.

If all of these items were summed up, the total would be not far from a million dollars, in addition to which the question of a reasonable profit to the private shipbuilder must be considered.

With these facts in mind, some allowance should be made in competitive bidding for the handicaps under which the private yards are laboring as against the Government-built ships. In the end it is likely to be found that in reality the vessel built in a private yard will cost the nation less than the Government-built ship, to say nothing of the quicker delivery and the additional expense involved in preparing the navy yards for building these ships.

The Geared Turbine and the Turbo-Electric Systems of Marine Propulsion

Successful Trials of Collier Neptune Fitted With Geared Turbines Compared With Performance of Sister Ship With Turbo-Electric Machinery

BY JOHN H. MACALPINE

This short discussion is called forth by the successful trials of the United States collier *Neptune* fitted with geared turbines by the Westinghouse Machine Company. She standardized on November 17 and commenced her full power 12 hours' trial on the same day. The machinery is reported to have acted admirably. The average results of the latter trial were:

Speed.....14.28 knots
Shaft horsepower .....7,175 total
Revolutions per minute of propellers.....115.34
Revolutions per minute of pinions.....2,003
Power constant (explained below).....5.22
Coal.....1.528 pounds per shaft horsepower hour
Water, turbines only, 13.4 pounds per shaft horsepower hr.
Water, all purposes..15.8 pounds per shaft horsepower hr.

The contract speed is 14 knots and the guaranteed coal consumption 1.8 pounds per shaft horsepower hour.

In a long article on "Reduction Gears," discussing fully both theory and practice, which will begin to appear in *Engineering*, London, during January, I deduce what I have called the "Power Constant" by which the performance of gears should be compared. It is

$$C = \frac{1{,}000\,P}{D^2 R}$$

where C = power constant.
P = horsepower transmitted by the gear.
D = diameter of pinion in inches.
R = revolutions per minute of pinion.

The factor 1,000 is introduced to make C fall, usually, between unity and 10.

It can readily be shown that in similar gears, loaded at corresponding points to the same intensity of stress, the value of C is constant; also, applying similar gears to a turbine of a given power and speed, the weight per horsepower is inversely proportional to the value of C. Hence the higher the value of C which can safely be carried the better the design or type of the gear and the more advantageous for adoption on board ship.

The "floating frame" was introduced to raise the safe value of C by producing and automatically maintaining very uniform distribution of pressure between the teeth and thus preventing great local rise of stress through slight errors of alinement of the gear and pinion. With the floating frame, errors of alinement, unless far outside the limits which would ever be allowed to occur in practice, produce no sensible effect. Thus the Westinghouse Machine Company, who have built and are building not far short of 200,000 horsepower of floating frame gears, have gradually raised this constant till $C = 4$ is regarded as a proper value, especially in marine work, and its adoption has met with perfect success. When the late Mr. George Westinghouse reduced the pitch diameter of the *Neptune's* pinions to 7 inches I greatly feared for a successful result as it involved raising C to over 5 and was a great leap beyond all precedent existing at the time. But it is completely successful, in spite of the fact, as I show reason to believe, that the ratio of length of helix to diameter is considerably above the best value. Gears where the bearings are rigid, or "rigid gears," seem always to run at a much lower value of C. This is to be anticipated, for, as calculation shows, an error of alinement of the pinion and gear bearings of 1/1,000 inch, even in a large reduction gear, is serious and will usually give rise to nearly "point contact," and consequently to highly localized stresses in the teeth. Setting the axes so closely as this is a delicate operation, and they will not remain so set. The highest result I know is for the rigid gear of S. S. *Vespasian* where, on the measured mile trial, C reached the value 3 for the mean of the highest runs. But in service her value of C is about 1.85. So far as I can find from published results this is about the high limit of load at which rigid gears are run, and many give much smaller values.

Thus experience confirms theory, showing that the introduction of the floating frame allows of an increase of load with equal safety to over two, and probably to three or more times that of a rigid gear. This I felt sure would be the case long before the first gear was built. In fact, where the effect of slight errors of alinement is so marked, it seems certain that at some time during the life of a rigid gear the length of tooth contact will be reduced at least half, and not improbably to much less than half, its proper amount. At half contact the maximum surface and internal stresses will obviously be approximately quadrupled. That the floating frame performs its function properly is demonstrated by the fact that after long runs, even under heavy loads, the rise of temperature of the pinion is found to be slight.

This high value of C allows, for a given power—

(a) A much smaller and lighter gear for a given ratio of reduction; or

(b) With a given diameter of large gear, of a greater ratio of reduction, reducing the speed of the propeller or increasing the speed and consequently reducing the size and weight of the turbine, and thus increasing the efficiency of the installation.

Though the coal consumption of the *Neptune* is fully 15 percent within the guarantee it cannot be looked on as satisfactory. This is the second set of turbines and gears which have been fitted on the *Neptune*. With the first set the ship failed on her endurance trial because of the inefficiency of the turbines and loss of fresh water thrown overboard by the air pumps. These original gears had acted perfectly but when the turbines were changed it was desired to increase their speed and reduce the speed of the propellers to 110 revolutions per minute, the same as that for the sister-ship *Jupiter* engined with turbo-electric machinery by the General Electric Company. Hence new turbines, gears, and air pumps, were fitted. In the case of the geared turbines for two foreign warships of 22,000 horsepower each, the Westinghouse Machine Company guarantees a water rate at full power of 10.8 pounds per shaft horsepower hour and a minimum rate of 10.5 pounds at from 80 to 85 percent of full load. The curve,

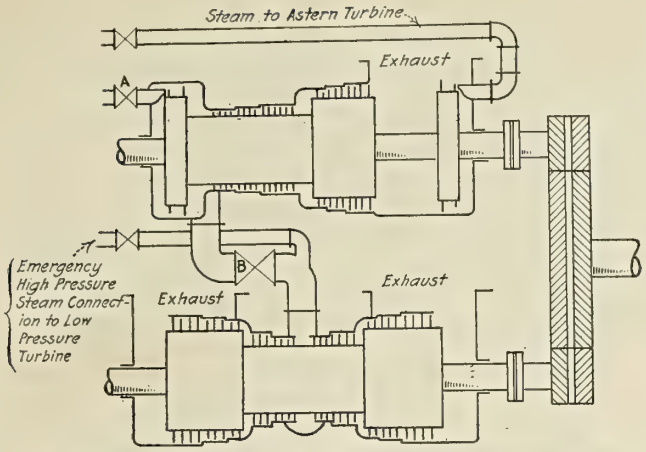


Fig. 1.—Diagrammatic Sketch of Westinghouse Divided Flow Turbine Applied to Reduction Gear

which is shown in the figure, is so flat that at quarter load the water rate is only 11.5 pounds, or 6.5 percent. above full power water rate. This is accomplished with what they call a Divided Flow Turbine for which, however, the method of calculating efficiency contains no new element, and thus the result is not problematical. They believe they have a very safe margin in the guarantee. The *Neptune's* turbine water rate of 13.4 pounds exceeds this full power foreign guarantee by 24 percent.

The Westinghouse Divided Flow Turbine was developed primarily for naval purposes, with a view to obtaining a steam consumption at cruising speed comparable with that usually obtained at full speed. As will be seen from Fig. 1, which is a diagrammatic sketch of a Westinghouse Divided Flow Turbine applied to a reduction gear, the high-pressure element is of the impulse reaction type, while the low-pressure element is of the well-known Westinghouse reaction, double flow type.

The operation is as follows: Steam is admitted to the high-pressure impulse wheel through separate groups of expanding nozzles, each group of nozzles being controlled by a hand-operated valve. At maximum load all nozzles are open. All of the steam admitted to the turbine through valve "A" does work on the impulse wheel, after which one-third of the total steam is expanded through the reaction blading of the high-pressure turbine, exhausting to the condenser. The remaining two-thirds of the steam passes through valve "B" into the low-pressure turbine, where the expansion is completed in the reaction blading, the steam exhausting finally to the condenser at each end of the low-pressure turbine. At cruising speed the cross-connection valve "B" is closed (position "C" on curve, Fig. 2), leaving only the high-pressure turbine in operation, in which case the steam is admitted to the high-pressure impulse wheel through such of the nozzles as are required for the reduced power. After passing the impulse wheel, the steam expands through the high-pressure reaction blading to the condenser.

It will thus be seen that at cruising speed a small turbine of only one-third the capacity of the entire unit is in operation at its full load rating, instead of having in operation a large turbine at fractional rating, as is usual in other marine turbine installations. Shutting off the low-pressure turbine at cruising speed assures a constant pressure of the exhaust from the high-pressure impulse wheel. By this means the energy available, due to expansion in the nozzles, is practically constant at all loads. This is especially desirable when the blade speed is reduced, which is the case at cruising speeds.

A further advantage is found in the fact that the low-pressure turbine operates only at the higher powers, thereby modifying the design of blading, because no attention need be paid to the conditions existing at cruising speeds. The high pressure turbine is bladed with a view to obtaining the highest economy at cruising speed, and, as it is only one-third of the total turbine, sufficient blading can be put in to give high economy at the reduced revolutions at which it operates when cruising. As provision is made for readily disconnecting the low-pressure turbine when on a long cruise, the desired condition is obtained of having fewer units in operation at cruising speeds than at full speed, which is the reverse of that existing on practically all of the turbine driven ships at present in commission.

From the foregoing it is evident that the Divided Flow Turbine has various qualities which make it peculiarly suitable for a gear drive. As two rotors each drive a separate pinion, both pinions meshing with the gear on the propeller shaft, scarcely any accident short of total disablement of both rotors can occur which will not leave the ship free to go forward at nearly full speed with either one or both rotors. The necessary change can be made by manipulating a couple of valves; or, at most, disconnecting a coupling, which might take half an hour. The flexibility and safety thus attained are much greater

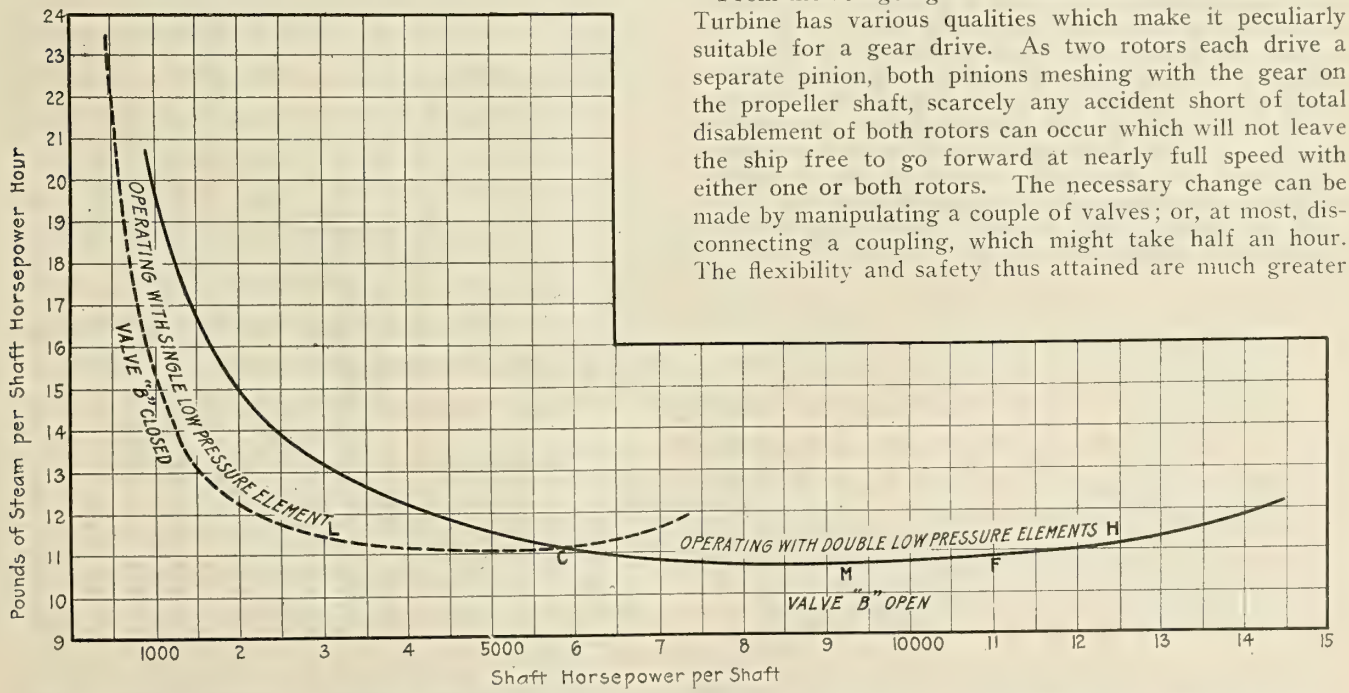


Fig. 2.—Steam Consumption Guarantee, Pounds per Shaft Horsepower Hour for 11,000 S. H. P. Divided Flow Geared Turbine Installation. Dry Steam, 260 Pounds Gage Pressure; 28.27 Inches Vacuum; Revolutions per Minute of Turbines, 3,600 at 11,000 S. H. P.

than those ascribed by Lieut. Robinson to the *Jupiter's* machinery.

The *Jupiter** on her full power trial consumed 1.664 pounds of coal per shaft horsepower for all purposes. This is not a good result. The excess over the performance of the *Neptune* is in part due to inferior firing and uneconomical auxiliaries; but it is also raised by the loss of efficiency in transforming the mechanical energy delivered by the turbine into electric energy and retransforming this into mechanical.

There were also two turbines built for the *Jupiter*. The first, after trial, was rejected and an improved design adopted. On account of the excellence shown by the shop tests the General Electric Company improved all their commercial designs to correspond with this second turbine.† The *Jupiter's* power is measured by a torsion meter on the propeller shafting after the energy has been twice transformed. Her full power water-rate, turbines only, is 11.68 pounds—better than that of the *Neptune's* turbines, but fully 8 percent worse than the full power guarantee for the foreign ships. This we might anticipate. For, with equally well designed machinery, the geared turbine will always show a considerable economy over the turbo-electric drive: the auxiliaries are practically the same; in the geared turbine we have a loss in transmission to the propeller shafting of only from 1 to 2 percent, while the double transformation of the turbo-electric drive at full power must entail a minimum loss of about 10 percent and sometimes a good deal more.

Let us now examine the result at 15 percent of full power, approximately half speed. The curve for the Divided Flow Turbine is still rising slowly and gives 18.5 percent increase over the full power rate. In the turbo-electric drive it is proposed to wind the motors for 30 poles and 50 poles †† so that at 0.6 of full speed of ship the turbines would run full speed. As the winding might readily be for 30 and 60 poles we may suppose the turbines running full speed for half speed of the ship. The *Jupiter's* turbine shows on reduction from 5,000 kilowatts to 750 kilowatts (= say 1,000 horsepower, or 500 horsepower per shaft) a rise in water rate of about 36 percent ‡ If the turbine has to be slowed there is at once an added drop of efficiency and, consequently, a slight rise in the speed of the ship, necessitating reversion to the smaller number of poles, would give a much greater loss than I am about to state. As 1.36/1.185 = 1.15 the Divided Flow Turbine shows 15 percent advantage over the *Jupiter's,* which, it should be noted, cannot be made Divided Flow unless the generators are driven by gears which, we shall see later, would effect a great improvement. At 500 horsepower, the motors of the *Jupiter* have fallen in efficiency to 88.5 percent, and no doubt there is some such drop in generator efficiency also, the curves of which are not given by Lieutenant Robinson. Possibly a motor having two sets of poles would give a somewhat better result, but at best we are left with a loss in the two transformations of from 16 to 20 percent or not much less. At reduced powers the loss in the gears rises very slightly and 4 percent would here be an excessive value, leaving an advantage in favor of the gear against the electric machines of about 12 to 16 percent. As 1.15 × 1.12 = 1.288 the total advantage of the geared turbine is about 25 to 30 percent, under this favorable supposition of full speed of the turbine driving the generator. I make a liberal deduction as the turbine for the *Jupiter* is smaller than that of the foreign ship.

These figures apply particularly to the *Jupiter* with her single turbine and generator. In a ship with two turbines and generators one would be stopped at much reduced power and the above losses considerably reduced but by no means annulled.

Further, even at full power the *Jupiter's* turbine has not reached maximum efficiency, and the slightest reduction from full speed increases the water-rate and that fall accelerates as the power continues to fall. This is very inferior to the foreign guarantee curve. Hence, what I believe were the most prominent claims for the turbo-electric system, increase of efficiency both at full and very low powers, are possessed in a higher degree by the geared Divided Flow Turbine.

There are three requirements of prime importance on shipboard—efficiency, simplicity, and lightness.

With the first I have already dealt. But, as every engineer knows, the maintenance of efficiency is surer the simpler the machine or system.

Lieutenant Robinson's papers are obviously written by a strong believer in the superiority of the turbo-electric drive. But one has only to study them carefully to be impressed by the complexity of the plan. The principal complication is the indirectness of the drive which, as we have seen, lowers efficiency. But besides that there are large air ducts, water-cooled rheostats, a very exact governor, switch and gage boards and control stand which not only have the usual pressure gages, levers, etc., but also an imposing array of electric meters, oil switches, rheostat, short-circuiting levers electrically locked by solenoids, mechanical locking devices, and so on, testifying eloquently to the complexity both of the system and of its operation.

The following are weights of corresponding parts of the main propelling machinery of the three sister ships. They contain the condensers, air and circulating pumps for each; for the *Cyclops* the reciprocating engines; for the *Jupiter* the turbine, generators, motors, switchboard, exciter and gear, cables, etc.; for the *Neptune* the turbines and reduction gears:

Cyclops	342.6 tons
Jupiter	223.0 "
Neptune	188.9 "

The following are carefully estimated weights for a 10,000 horepower twin-screw ship. It includes the main propulsive machinery without boilers, auxiliaries, etc. The estimate was made by the Westinghouse Electric and Machine Companies and on it they submitted bids:

(a) Geared turbines	274,000 pounds
(b) Turbo-electric drive (using geared generators)	304,000 "
(c) Turbo-electric drive (using direct-connected generators)	423,800 "

(b) is 11 percent and (c) 54.7 percent above (a).

The *Jupiter's* engine room extends 20 frame spaces and the *Neptune's* 18, a saving of 2 frame spaces or 5 feet.

It is stated* that "The present claims of the contractors for the machinery of the *Jupiter* are that it is lighter, takes up less space, and is more efficient than any other form of ship propulsion." These claims are far from being supported by the facts.

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* Most of my information regarding the *Jupiter* is derived from the *Journal of the American Society of Naval Engineers.* The references in the sequel are principally to two papers in Vols. XXV. and XXVI., by Lieutenant S. M. Robinson, U. S. N. There is also a paper by Lieutenant Robinson in INTERNATIONAL MARINE ENGINEERING, Vol. XX., page 19, which I have read in abstract in the *Journal of the American Society of Naval Engineers,* Vol. XXVII., page 199, since writing what follows. It does not modify what is said in the two earlier papers.

† See *Journal of the American Society of Naval Engineers,* Vol. XXVI., pages 347, 348.

†† See *Journal of the American Society of Naval Engineers,* Vol. XXVI, page 350.

‡ The curve in Vol. XXVII., page 201, *Journal of the American Society of Naval Engineers,* is carried down to 1,000 kilowatts, and slight extension shows the above result for 750 kilowatts.

* *Journal of the American Society of Naval Engineers,* Vol. XXV., page 550.

Lieutenant Robinson also puts forward the claim of less weight and space, but it is at once disclaimed in a footnote as not holding when the comparison is with geared turbines or the hydraulic transmitter. He also claims, as a valuable asset in a man-of-war, the short time of starting up and similarly disclaims it in a footnote. In all, he formulates a list of eleven claims which it would take far too much space to examine in detail, but no one of which would stand, better than those we have examined, in comparison with the geared turbine. I will only state one†—"(9) The readiness with which repairs can be effected. There is hardly any accident that can be conceived that could not be readily repaired by the ship's force." The burning out of the generator or motor, for instance, by short-circuiting, necessitating partial or complete rewinding? This claim is necessarily untrue of *any* system of propulsion. With the geared turbine, the pinions and turbines become so small that spare pinions and turbine rotors could readily be carried, as well as ample spare turbine blading, and that comes much nearer fulfilling the claim than is the case with the turbo-electric drive. It has sometimes been claimed as a great advantage that the turbo-electric drive can exert full power astern without having an astern turbine. As every marine engineer knows, full power astern will cause the engines to race. The Divided Flow Turbine, by the addition of a single two row impulse element for the astern turbine can develop fully 60 percent of the full ahead power on the same steam flow, which is ample. It adds no sensible complication or loss from friction. Both propellers may be promptly reversed by the operation of a single handwheel. This is even simpler than for a reciprocating engine and much simpler than the multiple operations described by Lieutenant Robinson for reversing the *Jupiter*.*

But the turbo-electric system has disadvantages peculiar to itself:

(1) The operation is unusually complex, as I have indicated, thus requiring higher skill and offering more chance of accident.

(2) It seems that a fall of voltage occurring at the same time as a variation of load on the motor (due to throwing over the helm or the natural action of the waves) may make it fall out of step and stop. This has actually occurred on the *Jupiter* and Lieutenant Robinson describes the prompt action ("the turbine is quickly slowed, the excitation of the generator is increased") required to prevent it. Still, might it not be very embarrassing in a storm or when tryng to keep perfect control of the ship if in danger of collision? Perpetual vigilance would be necessary but even then it must take time to re-establish normal conditions. This is the case with the *Jupiter*. Possibly it might have been reduced or obviated.

(3) To get the best results the design and winding of the motor must apparently be somewhat complex.

(4) It requires large air-ducts and fans to carry off about 10 percent of the full power against a simple oil cooling system for the gear.

(5) These air ducts may readily contain water or very moist air, especially when green seas are breaking over the ship. This would almost certainly lead at once to the burning out of any motor or generator it reached. This danger is admitted.

(6) If an engine room had been flooded great precaution would have to be taken before starting the electric apparatus which the water had reached.

As is well known, electrical generators and motors must be carefully dried out before load is applied. This in a large unit is a matter of 12 to 24 hours as a probable minimum.

With non-electric systems there is no corresponding difficulty.

(7) A very delicate governor is necessary.

(8) The engineers, in addition to being expert in steam engineering, must also be expert in electric.

There are some disadvantages peculiar to the *Jupiter* which might be avoided.

(9) The *Jupiter* has only one turbine and generator. Consequently, while she has two screws she has not the advantage of safety which principally led to the introduction of twin screws. If the turbine, generator, or any of their connections break down she is helpless. This is not imaginary for it has already occurred on the *Jupiter*.

If the engine-room space will allow, a second turbine and generator should be fitted on her. If of the same size as those now installed it would bring her weight up nearly to that of the *Cyclops* with her reciprocating engines.

(10) Due to there being only one turbine and generator, both motors must go at the same speed whether they are both going ahead or one going ahead and one astern. Consequently the ship cannot be steered by its propellers, as has frequently had to be done—if the rudder or steering gear is out of service, as has often happened in marine experience, how is the ship to be brought into port?

*No other propulsive system has this great weakness.**

(11) Due to this defect the turning circle is increased (Lieutenant Robinson does not say how much), increasing the liability of collision and the space necessary for fleet maneuvers.

Lieutenant Robinson only claims advantage for the turbo-electric drive in ships of 5,000 horsepower and above. Why the disadvantages become predominant below this power he does not state. The geared turbine can advantageously be applied to all powers and speeds—to slow speeds by double reduction, using which the ratio of reduction may readily be as high as 60 to 1, or more if desired, without excessive size of the large gear.

I have no doubt whatever, after prolonged and careful study of every phase of this most important question, of the great superiority of the geared turbine at full and reduced powers and for every description of ship. That, I believe, is the judgment of a very large majority of marine engineers now, and I feel certain will be the conclusion from experience within a very few years.

Since writing the preceding article I have read Mr. W. L. R. Emmet's paper entitled "Some Comparisons Relating to Electric Propulsion of a Battleship," read last month before the Society of Naval Architects and Marine Engineers, in New York. The paper is only a sketch and no attempt is made to give full information. It contains a number of minor inaccuracies. For instance, the steam consumption of the main drive of the *Jupiter* is given as 11 pounds instead of the published result of the Official Trial Board, 11.68 pounds. Again, "The *California* has two turbines, the *Utah* ten, and the proposed Parsons geared equipment has thirty-two" is neither a full nor a fair statement. The *California* has four turbines, two of which drive the main generators and two the exciting units. If it had four turbines and generators for the main drive, making each shaft quite independent, it would be a much safer ship; so that what he claims as

† *Journal of the American Society of Naval Engineers*, Vol. XXVI., page 350.

* *Journal of the American Society of Naval Engineers*, Vol. XXVI., page 340.

* The *Jupiter* was swung to adjust compasses by going ahead on one screw and astern on the other. Curiously, Lieutenant Robinson thinks this cannot be done with any other form of propulsion. It is almost invariably used to maneuver in narrow waters.

a merit is a serious defect. The weight and space required for the machinery would then, however, have been greater. Also, if he had specified the motive machinery of the *California* as fully as he has that of the *Utah*, he would have added the two electric generators and four motors with their connections, also the two turbine driven exciting units. Further, why go back over two and one-half years to find an extremely complex proposal of Sir Chas. A. Parsons when he must know the much simpler and lighter proposals which have since been put forward?

He states: "At full speed the *California* propellers will make 175 revolutions per minute, this being about the lowest speed of propellers which is practicable within the space. The propeller speeds proposed for the sister ship with Parsons turbine drive is 240 revolutions per minute, and comparisons by Dyson's method indicate that this speed difference will give the *California* an advantage of about 9 percent in propeller efficiency." The inference apparently is that the gear limits seriously the propeller speed available. This is not so, especially in floating frame gears. We may choose independently the most desirable speed of propeller and also that of the turbine and link them up by a suitable gear. In all but comparatively slow ships this is done by a single reduction; in slow ships by a double reduction, as already explained above, but without serious change in weight or in the space occupied.

The *California's* motors can be used with 24 poles or 36 poles. That is the turbines and motors will run full speed at full speed of the ship and also at two-thirds full speed of the ship. This seems to be far from a good arrangement for cruising at half-speed. Indeed, any bipolar arrangement is little more than a make-shift. It seems to make it probable that he will forfeit what he curiously describes as "very heavy penalties" at some of his speeds.

The steam consumption for *California's* main turbine, condensing auxiliaries, and—what do not exist in the geared turbine system—exciting units and ventilating blowers in the engine rooms, is guaranteed to be 11.9 pounds per shaft horsepower hour at maximum speed (22 knots).

The Westinghouse Machine Company's guarantee for a proposed battleship of 64,000 horsepower, for the main turbines is 10.2 pounds per shaft horsepower hour at full speed (28 knots), and they believe they have an eight percent margin. Even without this margin, and adding steam for the condensing auxiliaries, the steam consumption of this battleship will still be well under the *California* guarantee.

The estimated weight of the *California's* "propelling machinery without condensing auxiliaries is 530 tons, and that of the turbines originally proposed was 653 tons." The *California* has 37,000 shaft horsepower, 22 knots, and 175 revolutions per minute of propellers.

The above proposed battleship is of 64,000 shaft horsepower, 28 knots, and 420 revolutions per minute of propeller. The estimated weight of turbines, gears, and thrust blocks, is 212 tons. If it seemed desirable to bring down the propeller speed to correspond with that of the *California*, this could be done without nearly approaching her weight of machinery given above, although the horsepower is 73 percent greater. As the cost per pound weight of machinery would certainly not be greater in the case of the geared turbines, the price of the installation would be less, not 46 percent greater as Mr. Emmet indicates.

The development of the motor and generator was naturally followed by that of the power house. Before its advent the transmission of power to a considerable distance was, if we omit the actual transport of fuel, a practical impossibility; and it made the transmission even within the limits of a factory greatly simpler in many cases. But carrying about the power house and making two transformations of energy, mechanical to electric and again electric to mechanical, before it is applied *in the same room* is surely a development, which could only be justified by greatly increased economy. As I have shown, this increased economy does not exist at high or low power.

It will be readily seen that the conclusions Mr. Emmet desires to impress on the reader are very different from mine, but I submit my figures with the utmost confidence in their accuracy.

Ocean Shipping

Believing that the development of a sound national shipping policy is rendered difficult by the general lack of knowledge of the fundamentals of ocean transportation, the National Foreign Trade Council, of which Mr. James A. Farrell, president of the United States Steel Corporation, is the chairman, has published a monograph entitled "Ocean Shipping." It is a simple presentation of the basic principles of marine transportation with particular reference to the foreign trade of the United States. It is expository and non-argumentative in tone. It compactly presents information from many sources covering aspects of ocean shipping as an industry which have been shown in the discussions of the past year to be little understood in this country. The question is treated from the standpoint of normal conditions rather than those of the present war, it being recognized that the upbuilding of an American merchant marine will be a long task affected by the keen shipping competition of peace rather than the "boom" characteristics of war.

"Ocean Shipping" deals with the merchant marine question as one relating to the establishment of an industry which should add to the national wealth by activity in the world carrying trade. It says:

"Out of 44,000,000 tons of shipping owned in the world, fully two-thirds consist of tramp steamers, of which Great Britain alone owns 70 percent of the whole."

The necessity for the tramp to rove the world over in search of cargoes is vividly described and examples are given of the difficulty of steamers obtaining return cargoes—this problem naturally affecting freight rates.

The enormous advance in freight rates due to the war, which it is stated has removed from private commercial employment between 20 and 25 percent of the total world's shipping, upwards of 9,000,000 of the 44,000,000 tons, by reason of destructive immobilization and impressment for governmental service, is described, but the other examples of the shipping business relate to normal rather than war conditions.

The monograph states that in the chapter on "United States Ocean Freight Bill," an estimate is made of the cost of transportation of the foreign commerce of the United States in the normal year ended June 30, 1914, placing it at $153,520,791 (£31,500,000), of which about 10 percent is estimated to have been carried under the American flag, and the remaining 90 percent, or $138,168,712 (£28,400,000), under foreign flags. Out of this it is estimated probably that not more than approximately $46,848,000 (£9,600,000) was paid by American interests, being the freight on imports in foreign vessels. The freight on exports, as a general rule, is paid by the consumer.



Fig. 1.—Coastwise Collier *Jonancy* on her Trial Trip

Coastwise Collier Jonancy

Tenth Vessel Built by New York Shipbuilding Company for Fleet of 17 Colliers of 126,700 Tons

The New York Shipbuilding Company launched at Camden, N. J., on November 9 the single screw steel collier *Jonancy,* which is a sister ship of the *Virginia,* launched by the same company on October 23. The principal dimensions of these vessels are as follows:

Length between perpendiculars.....319 feet
Beam, molded.....49 feet 3 inches
Depth, molded.....27 feet 6 inches
Draft, loaded.....22 feet 8 inches
Deadweight carried at this draft.....5,450 tons
Gross tonnage .....3,625 tons
Speed at sea, loaded.....10½ knots

The vessel has been built to the order of the Pocahontas Navigation Company, and is of the same type as the *Norfolk,* built by the New York Shipbuilding Company for the Coastwise Transportation Company. The construction is in accordance with the requirements of Lloyd's Register of Shipping and under the supervision of the Coastwise Transportation Company.

This is the tenth vessel built at these works for the same management, bringing the total deadweight carrying capacity of completed colliers up to 70,000 long tons; there are seven other colliers still on order, which will raise the carrying capacity to 126,700 tons for the whole fleet of seventeen vessels.

The vessel has a single deck of steel, with poop 80 feet, bridge 17 feet and forecastle 30 feet long, seven steel watertight bulkheads, two pole masts, straight stem and semi-elliptical stern. A deep double bottom is fitted all fore and aft for the carriage of water ballast, and particular attention has been paid to the construction of this part of the vessel, the plating being of extra strength and fitted flush; no wood ceiling is fitted. A deep tank is also fitted amidships for the carriage of water ballast.

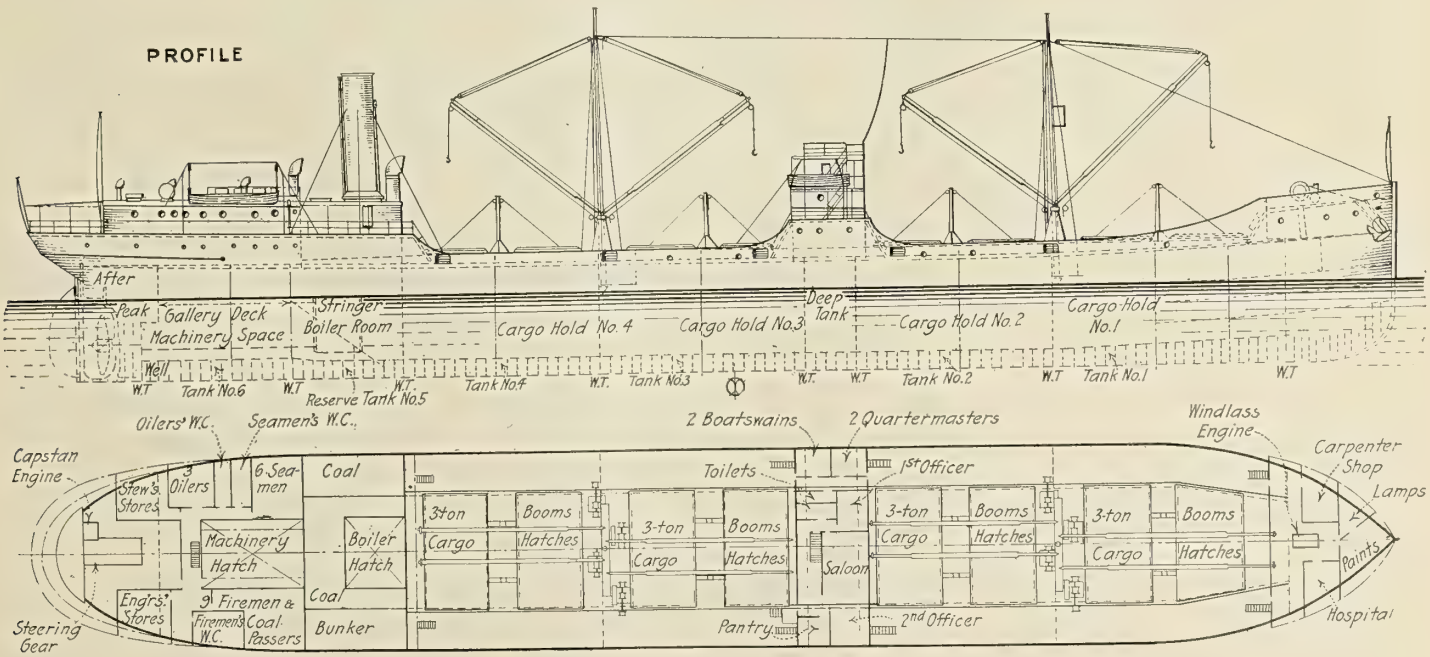


Fig. 2.—Profile and Main Deck Plan

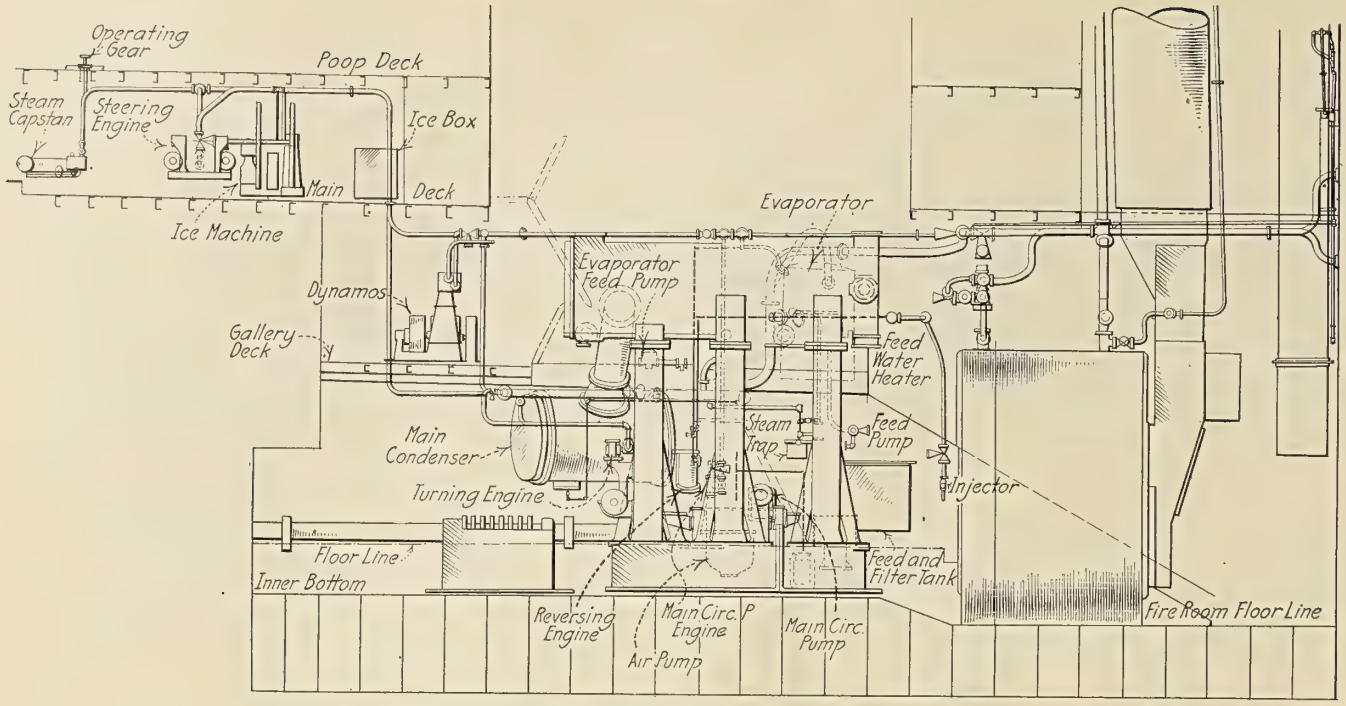


Fig. 3.—Longitudinal Section Through Machinery Space

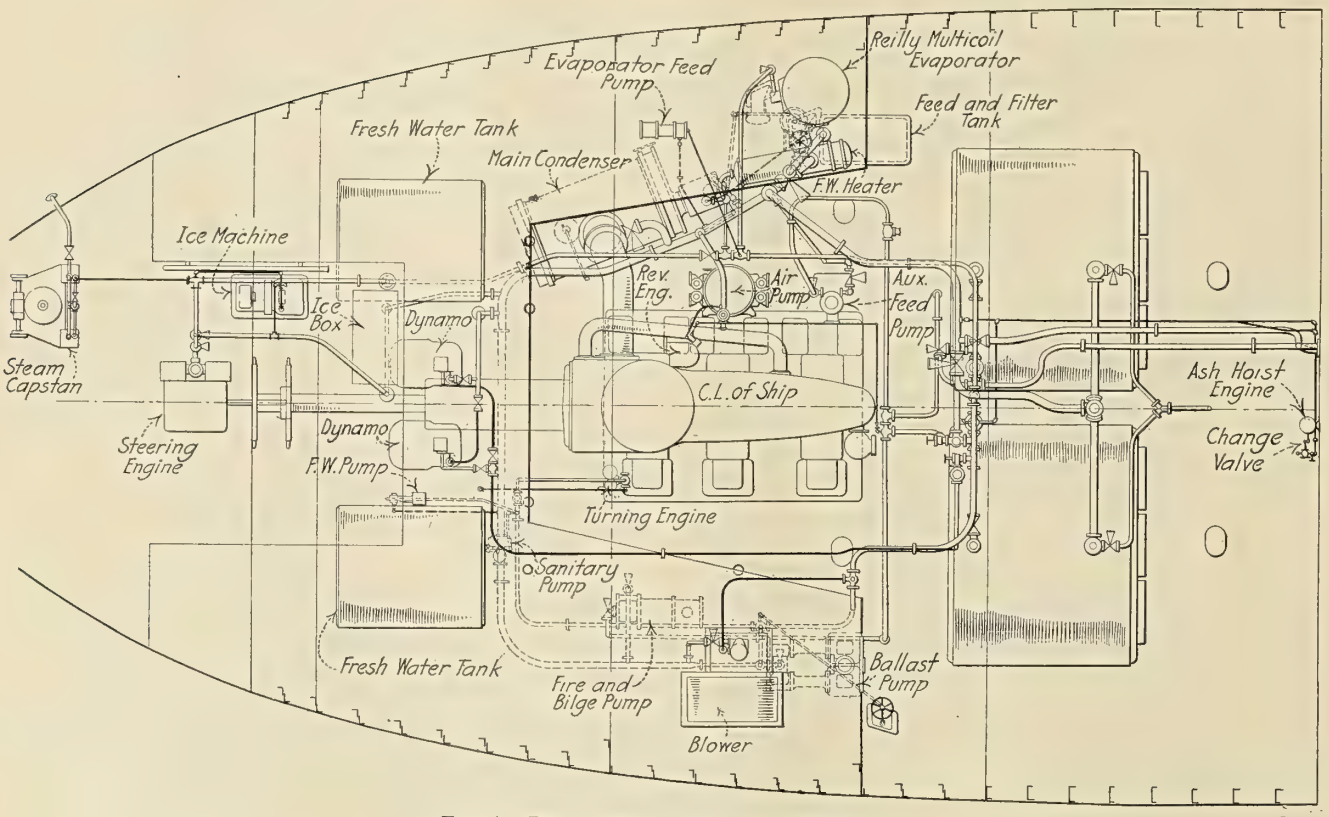


Fig. 4.—Plan of Engine and Boiler Rooms

The four cargo holds are entirely clear of beams and pillars, the deck being supported by deep arched beams and web frames fitted midway between the watertight bulkheads. A continuous trunk 24 inches deep by 28 feet wide is carried on the upper deck for the full length of the cargo spaces, the sides forming strength girders between the bulkheads. Large steel cargo hatches are fitted in top of this trunk, eight in all, two to each hold. Eight steam winches are fitted in connection with two masts fitted with four booms each, for the working of the cargo. Four pairs of king posts for raising the hatch covers and securing them in place when open are fitted.

The coal bunkers are at the sides of the vessel in the boiler room and in the poop 'tween decks, with hatches on the poop deck and pockets leading to the fireroom. The peaks are both fitted as water ballast tanks.

The accommodations consist of a midship deckhouse on the bridge deck for the captain's stateroom and a spare room, with a pilot-house above. The saloon, officers' and petty officers' berths, pantry, toilet, etc., are in the bridge. The engineers, cooks, steward, messrooms, refrigerator, toilets, galley, etc., are in side deckhouses on the poop deck,

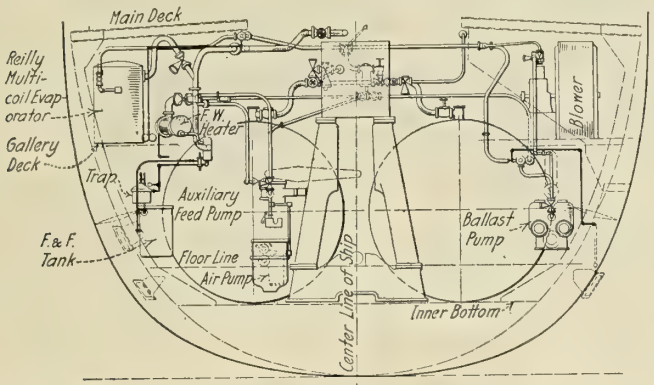


Fig. 5.—Section Through Engine Room, Looking Forward

and the oilers, seamen and firemen are berthed in the poop abreast the engine casing.

A steam windlass is fitted forward with the wildcats and warping ends on the forecastle deck, and the engine fitted below in forecastle. A steam capstan is fitted on the after end of the poop deck, with the engine fitted below. The steam steering gear is fitted on the upper deck abaft the engine casing with connection to the steering stations in the pilot house and on the navigating bridge, an auxiliary

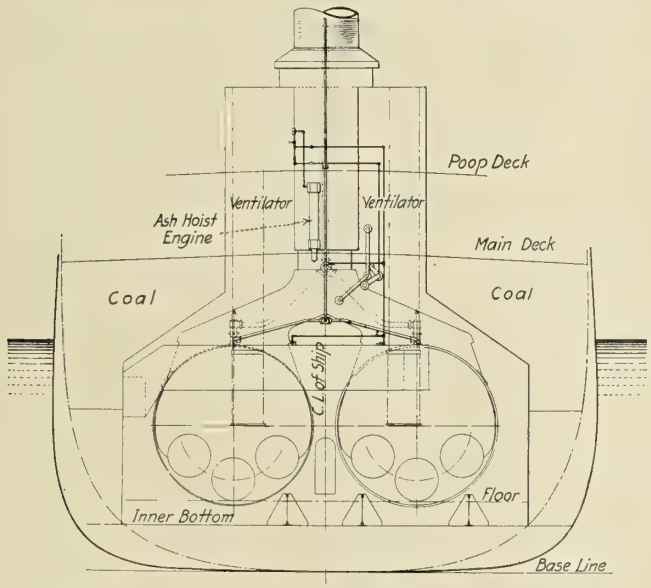


Fig. 6.—Section Through Boiler Room, Looking Aft

hand screw gear being fitted to the crosshead on the rudder stock on the upper deck.

The propelling machinery is placed aft, and consists of one triple-expansion inverted reciprocating engine of about 1,800 indicated horsepower, and two single-ended Scotch boilers having a working pressure of 200 pounds.

The engine has cylinders 21, 35 and 58 inches diameter by 42 inches stroke. The boilers are 14 feet 3 inches diameter and 11 feet long and work under Howden's system of forced draft.

The vessel is intended for the coastwise coal-carrying trade between Baltimore and Boston and is capable of steaming at 10½ knots loaded at sea.

The Drafting Room

BY H. C. ROBINSON *

Shipyard managers from time to time install various systems and are constantly prescribing for improving efficiency in the production end of the yards; studies are made to reduce operation in the shops; various methods are adopted in the form of bonuses and piece work to increase the output; but how many shipyards recognize the value of the drawing room and have looked deeply into the question as to whether work now performed elsewhere in the plant could not best be performed by a technical force of especially trained men before the work enters the yard?

The most unappreciated division in many shipyards is the drafting room. Draftsmen are generally looked upon as necessary evils—as non-producers. Their work cannot be put on a piece-work basis, nor timed, nor accurately estimated. The work on a plan is often greatly involved and the instructions given a draftsman when starting a job can only be in outline. A plan is the product of a man's mind, and no two men make a design alike. One construction will cost more than the other to manufacture; one may be more efficient. This is the human element that cannot be predetermined. It is owing to this perplexing element, possibly, that most systems start where it is plainer sailing, after the plans have been completed.

It is true, there are volumes written on how to conduct a drafting room, and they will be found to contain all manner of schemes to cut down the drafting work and eliminate the draftsman's time—non-productive labor; but very few suggest how more work could be done in the drafting room by men best suited to do that particular work.

It is the intention of this sketch to show that a highly paid drafting force may mean a low cost of production.

A good draftsman is obliged to have a fairly good idea of a number of trades; possess sound judgment on design; an eye for symmetry; have a knowledge of cost for labor and material; ability to plainly and intelligently present on his plan his ideas to others. He must have a good education and acquaint himself constantly with current practice, specifications, building regulations and general information. Otherwise he is obliged to work under instructions of those that do keep posted and who work possibly many hours more than credited for. Men of this type do not long remain draftsmen, for if there is not room further up they generally get out of the business.

While higher salaries would, of course, correct this to a large extent, the impracticability is realized of paying a man exactly what he may be worth; as, for instance, a salesman is paid in proportion to his sales. In large drafting rooms wages must be held within certain limits, and there are many men reconciled to the conditions wherein he receives so much per hour, and as most mechanics, upon receiving journeyman's wages, are satisfied to remain there with no more encouragement than the chance of obtaining at some time or another a promotion in their respective trades, so are these draftsmen working year by year in the drawing room, with the hope that by some action they will receive advancement. There are others, who, fully realizing the difficulties in the way of advancement, work for the self-satisfaction of accomplishing something; work because it is the natural bent of an aggressive human being. These latter are the men for whom every effort should be made to hold. However, possessing the above qualifications, this valuable labor should be most carefully handled to obtain its full worth.

* Chief Draftsman, Hull Division, Philadelphia Navy Yard.

A great mistake is often made in continually hurrying a draftsman. If a man is slow, and that is his only fault, he should be paid accordingly. If he is a loafer, discharge him. A loafer will not exert himself to look up data, to verify information, to make calculation where any chance of failure might take place; to utilize patterns and dies or to study the costs of design. To hurry such a man only makes him leave more to chance and give less thought to the quality and accuracy of his work. The writer has seen in operation an individual curve of performance for each draftsman, whereby a time which was allotted by the chief draftsman for making a plan was shown in comparison with the time actually taken. If the actual time was below the estimated it went to the credit of the draftsman, and vice versa. It will be noted that time is the only element considered. This scheme not only demoralized the force to a certain extent from an ethical standpoint, but encouraged the elimination of careful thought and study. Then again it is taken advantage of if, through some unforeseen circumsctances, the time

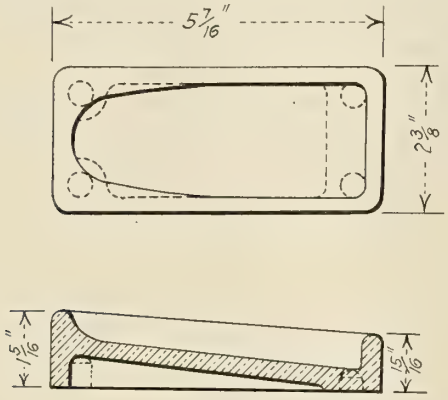


Fig. 1

allotted by the chief draftsman is not required. If the draftsmen were merely delineators, placing with pen and ink the thoughts of others on paper, such a method as just mentioned might be well; but in shipbuilding establishments or navy yards the detail of designs to a great extent is determined by the more responsible draftsmen. Again, the time spent on a plan is often of small consequence compared to whether the plan has been developed to insure the minimum cost to manufacture or the time spent by the dozen men that may be engaged on the job in the yard after leaving the draftsman's table. This is to say nothing of the efficiency of the design, cost of repairs, etc. In this connection it would be interesting to know what percentage of repairs in our navy yards, for instance, is directly due to faulty design originally.

In regard to costs, to illustrate what a draftsman can ultimately cost a concern, is shown by the following example:

A simple casting, as shown in Fig. 1, made to fasten on a shelf to take a rifle butt in its stowed position, was designed and actually a large number of castings were made of scrap brass material, file finished, and fastened with four brass machine screws. Disregarding other means of stowage design, by merely changing the material to semi-steel and fitting one screw at each end, which would have given entire satisfaction, would have saved this particular job approximately $40.00 (8/6/8). As this fitting was turned out of the drawing room in about one hour, it may be seen how much damage could be done in a year by one man. The above is just an instance where the cost of work in the yard was doubled by the design.

The question naturally arises, supposing sufficient inducement to hold an organization were given men of ability, what would be the saving in a year on the total amount of work turned out by one of our shipbuilding plants or a navy yard? It may be noted in connection with the above example that this fitting was developed from a type plan calling for six screws.

With the method of routing work by operations (which is bound to come about in all yards sooner or later), which is another subject entirely, it is necessary to turn out work from the drawing room with every ounce of information for the planner's guidance. In the future, structural plans, joiner plans, etc., will not only be complete in every detail, but put in such form and accompanied by such information to permit its adaptation to the accounting, planning and routing systems of the yard. Such methods add a third more work, in a drafting room at least, over the methods practiced in many of our yards to-day. But, if such a method permits of lower piece-work prices by enabling a man to accomplish more, and also allows of hiring less skilled labor by having the work thoroughly thought out and planned in advance, the comparatively small added expense in the drafting room is of small consequence.

It has been found at the Philadelphia navy yard and carried beyond the experimental stage, as evidenced by the low bid for the battleship recently opened by the Navy Department, that the ultimate cost of production is greatly reduced from the old-fashioned methods where the foreman, his assistants, and down to the mechanic's helper, were deciding questions that should have been decided before the job left the office.

To sum up, the draftsman, by virtue of his position, controls largely the cost of work, and if specially fitted for the work in hand is invaluable to his employer, for they are hard to find. In other words, a high-priced drafting room may mean low cost of production, and when production costs are running high it is suggested that before installing a new system, investigation be made to find if false economy is being practiced in the drawing room.

Annual Motor Boat Show.—Following an unbroken succession of eleven splendid exhibitions, the Twelfth Annual National Motor Boat Show, to be held in Grand Central Palace, New York City, opening January 29 and closing February 5, will eclipse all of its predecessors. There is hardly a type of pleasure motor boat but that will be exhibited at the coming show. Motor-driven river skiffs, power tenders, rowboats, designed especially to be driven by outboard motors, small craft designed for use on inland waters and in sheltered islands, fast runabouts, speed boats of varying design, express day cruisers and commodious yachts, will be shown in lengths ranging from 8 to 60 feet. It is planned to show two 60-foot cruisers, widely different in design and general appearance. Motors will be shown of a wide variety in sizes and types. Practically every engine builder in the United States, and makers of one or two foreign motors which will be shown, have evolved new ideas in the construction of these power plants in their application to various kinds of boats. Refinement of outline, reduction in the number of moving parts, economy of fuel, and many other interesting innovations will be displayed before the delighted public. Accessories, too, will have their departments, and many new inventions and improvements will be put on view for the first time. With the wonderful impetus that has recently come to the motor boat industry in this country, the manufacturers and builders are anticipating that the year 1916 will witness the largest volume of business that has ever been accomplished. Plans are accordingly being made to care for the largest attendance that has yet been known in connection with these exhibitions.

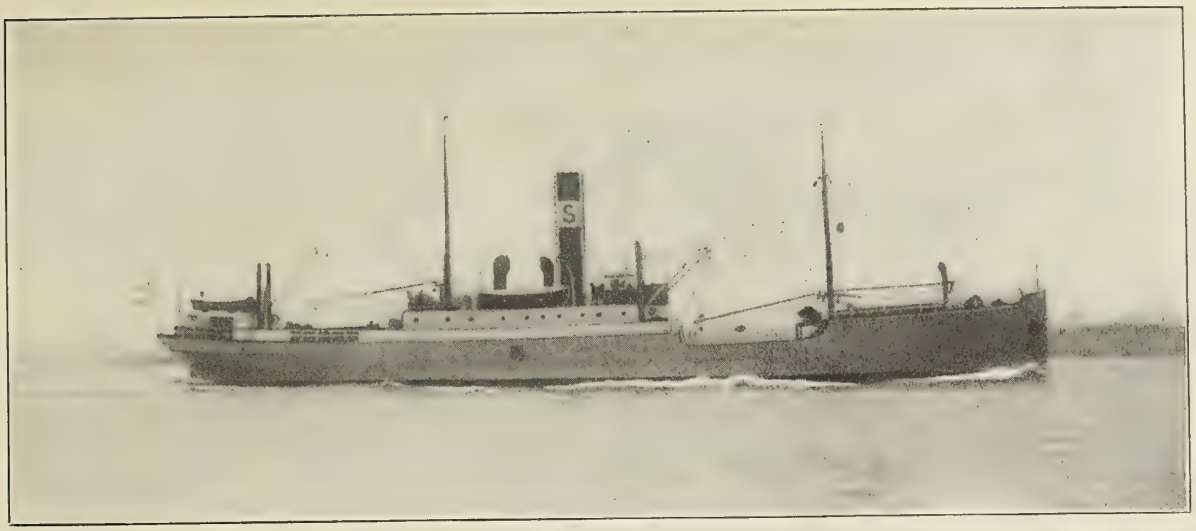


Fig. 1.—Electrically Propelled Steamship *Mjölner*

Electric Propulsion on a Merchant Vessel

Ljunstrom Turbo-Electric Machinery Installed on Swedish Coastwise Merchant Steamer of 2,225 Tons Displacement

As electricity is claiming more and more attention in marine engineering circles as a means for ship propulsion, the following may be of interest as showing how this problem has been approached in Sweden with very satisfactory results in moderate-sized vessels.

The vessel in question, the S. S. *Mjölner,* owned by Stockholms Rederiaktiebolag Svea, is built for traffic along the Swedish coast with Gothenburg as one terminal and Stockholm or some harbor farther north, eventually Gevle or Sundsvall, as the other one, and touching the larger intermediate harbors. In order to be able to maintain regular times of arrivals at the intermediate harbors the steamer is provided with more power than is generally considered sufficient for coastwise steamers. She has a speed of about 11 knots without forcing.

DIMENSIONS OF THE STEAMER

Length between perpendiculars	225 feet
Beam	36 feet
Depth, molded	15.5 feet
Draft at full load	14.76 feet
Block coefficient	0.66
Displacement	2,225 tons

In order to be able to make the speed mentioned above, the machinery must develop about 900 horsepower at the shaft.

The steamer is a single-decked vessel with a bridge deck running straight from abaft the main hatch and with one long back going from the stem to within 8 feet forward of main hatch. Quarters for the officers and crew have been arranged in deck houses on the upper deck midships

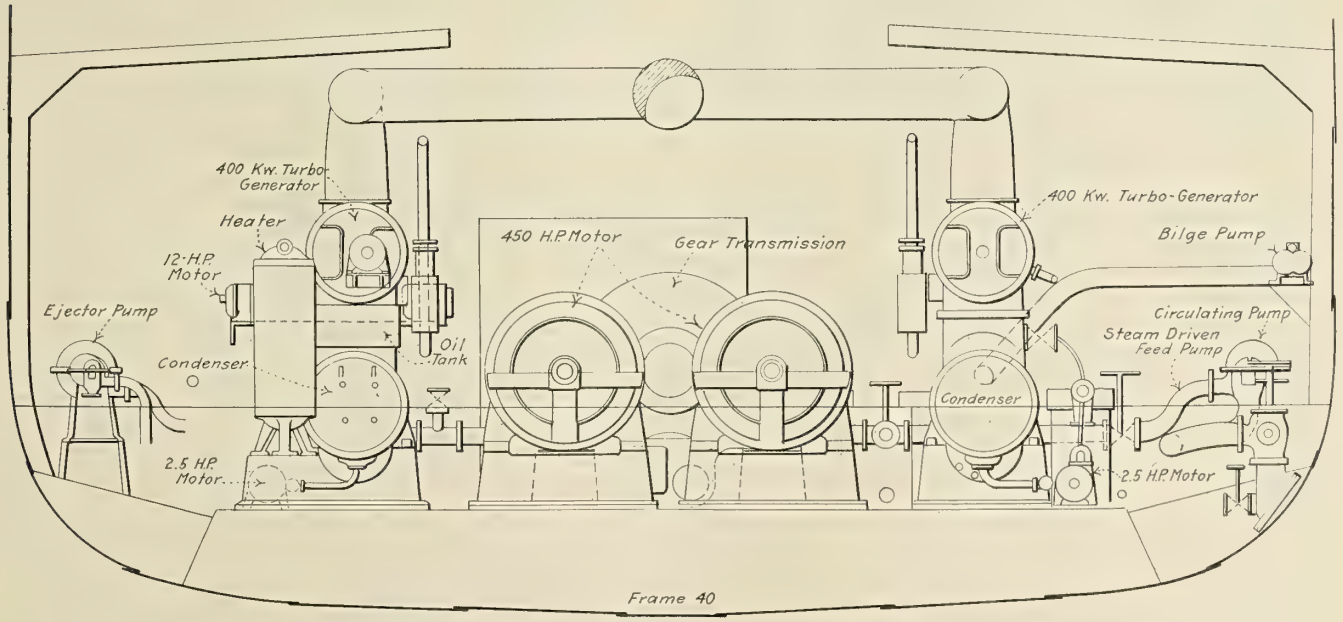


Fig. 2.—Section Through Engine Room, Showing Turbo-Generating Sets, Motors and Auxiliaries

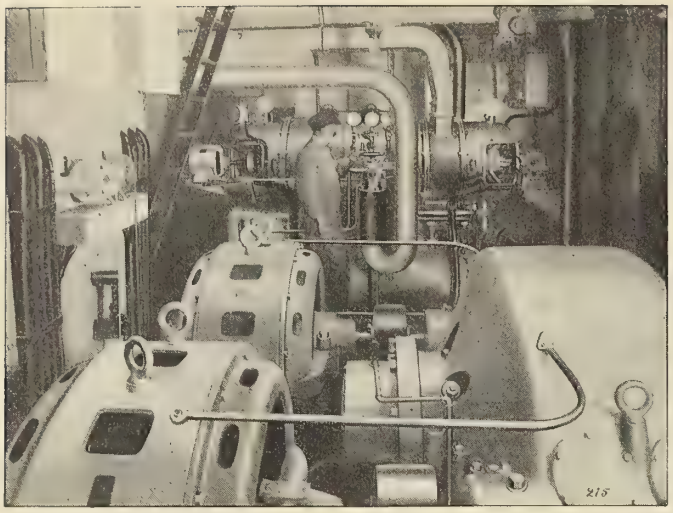


Fig. 3.—View of the *Mjölner's* Engine Room

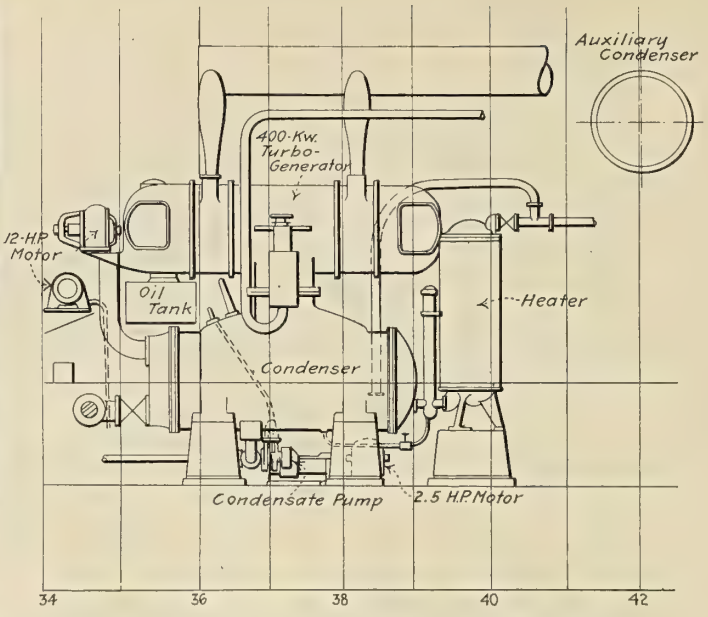


Fig. 5.—Longitudinal Section Through Engine Room

as well as abaft, and also abaft on the main deck.

The vessel is provided with two holds with two hatches for the forward one and one hatch for the after one and five steam winches with booms necessary for loading and unloading.

Although the steamer is classified in Bureau Veritas, I ✣ 3/3 G. I. I. P. R. A. & C. P., the dimensions of the stem, the propeller frame and the rudder are at least 25 percent and of the planking at the ice belt at least 10 percent in excess of the requirements of her class, so as to provide extra strength for navigation in ice. There is a continuous double bottom from stem to stern arranged for water ballast, except under the boilers, where the tanks are dry.

The Ljungstrom Turbo-Electric Machinery

This plant is made up of two similar units, each consisting of one 400-kilowatt double rotation turbo-generator working at a speed of 7,200 revolutions per minute and generating three-phase alternating current at 500 volts and 120 full cycles per second. The generated current is used to drive two three-phase motors, which in their turn drive, through pinions with inclined teeth, a common gear fastened to the propeller shaft. The motors make about 900 revolutions per minute and the propeller shaft 90 revolutions per minute.

Each turbo-generator unit, consisting of one turbine and two electric generators, is mounted directly on top of an ordinary surface condenser and is provided with elec-

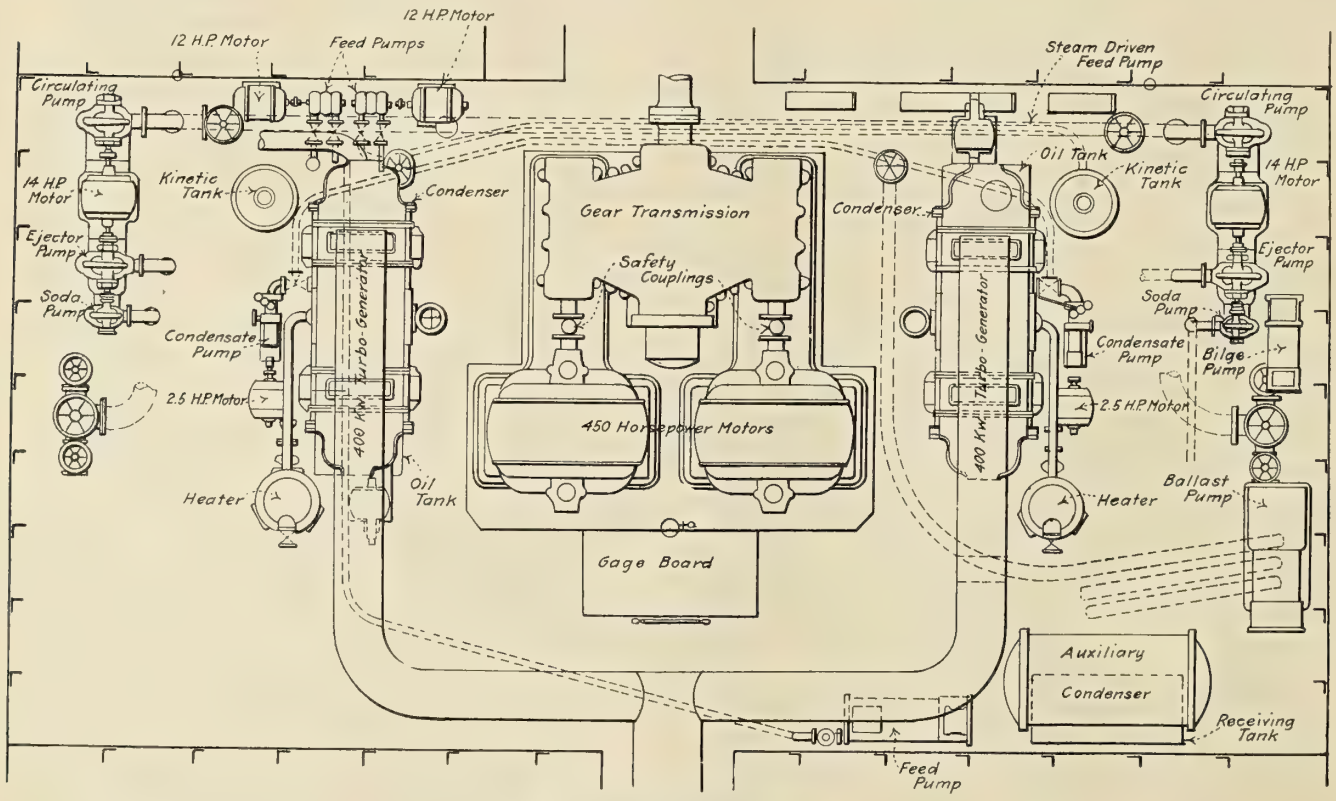


Fig. 4.—Plan of Engine Room

trically driven air, circulation and feed pumps. The air pump is of the dynamic jet type and the two other ones of the centrifugal type.

The condenser is of the counter-flow marine type with a liberally dimensioned cooling surface, which allows 95 percent vacuum at full speed. The above-mentioned pumps are so arranged that they may be used for only one of the generator units as well as for both, whereby the danger of complete breakdown of the machinery is considerably minimized.

The bilge pump is independently driven by steam.

The maneuvering is accomplished by electrical means. The speed is regulated by cutting out or in resistances in the motor fields and reversing is by changing the pole phases. When the generators from one cause or another are unloaded, the automatic regulator cuts off the steam in corresponding degree.

The pressure from the propeller is taken up by a ball bearing at the forward end of the shaft which carries the common gear, but besides that there is a bearing of the common thrust type, which is brought into action if the ball bearing should fail.

The lubrication of the moving parts of the generators and auxiliary machinery, as well as the gear transmission, is done automatically.

The steam required by the turbo-generators is furnished by two boilers of the common cylindrical type at a gage pressure of 218 pounds per square inch and a superheat of 235 degrees. The boilers are 10 feet 10⅛ inches diameter and 10 feet 8¾ inches long, and have a total heating surface of about 2,129 square feet (exclusive of the superheater) and a total grate surface of 58 square feet. Each one of the boilers has two corrugated furnaces, 35 inches inside diameter, and is provided with Howden's forced draft and Wm. Schmidt's superheater.

The air for the forced draft is obtained from the generators by ducts leading the ventilating air from the rotors to the smoke chamber, where it is heated in the ordinary way before it is brought into the furnaces.

The superheater has a total heating surface of about 770 square feet and is divided into 48 sections. The boilers also supply saturated steam to the steering machinery, to the engines for the electric lighting, to the tank, feed and donkey pumps, to the ash ejector and the deck auxiliaries. The feed water is led through heaters and filters before it re-enters the boilers.

In order to protect the main condensers from grease and dirt from the steam-driven auxiliaries and deck machinery, an auxiliary or winch condenser is installed with all necessary piping.

Safety Couplings

As the vessel has to navigate in ice-filled waters, a safety device is introduced the function of which is to prevent the breaking of the propeller shaft or stripping of the gear teeth. This safety device consists of friction couplings located between the motors and the pinions.

The maneuvering arrangements are so made that one man alone can take care of the machinery without difficulty.

Efficiency of the Machinery

By using the above described turbo-electrical driving method, it has been possible to design each one of the various parts of the machinery, such as the turbines, motors and propeller for the most suitable speed and other requirements. The plant thereby obtains the highest efficiency throughout, resulting in 42.3 percent less coal consumption than the sister boat *Mimer*, which is equipped with common reciprocating machinery. The guaranteed saving of coal was 30 percent.

Furthermore, the available space for cargo is considerably increased, not only as a consequence of the comparatively small space required for the turbo-generators themselves, but also due to the reduced coal consumption the incidental machinery, such as coal boxes, boilers, etc., is smaller.

The earning capacity of the vessel is consequently considerably increased throughout, which in connection with the decreased expenses for fuel will materially increase the net earnings.

Coal Handling Equipment at Pittsburg and Conneaut Dock

Last year the McMyler-Interstate Company built at its works at Bedford, Ohio, for the Pittsburgh & Conneaut Dock Company, a subsidiary of the United States Steel Corporation, at Conneaut, Ohio, a car-dumping machine designed to handle 100-ton cars. The machine is provided with a disappearing haulage car, so that the haulage car runs backward under the loaded car, and in this way climinates the delay which would be occasioned by holding the loaded car on the incline until the haulage car had reached the pit.



Car Dumper at Conneaut Docks

The machine is electrically operated in all the smaller movements, while the large units are operated by steam. Electrical operation affords better control and makes it possible to deliver the coal in the hold of the vessel with minimum breakage and delay. The operator can raise or lower the inner or outer end of the pan, swinging the telescope back and forth and revolving the trimmer all simultaneously. The machine is also provided with counterweights so as to reduce the amount of power required to operate it.

Three hundred and fifteen cars of coal have been transferred from the cars to vessels in seven hours—an average of 45 cars per hour.

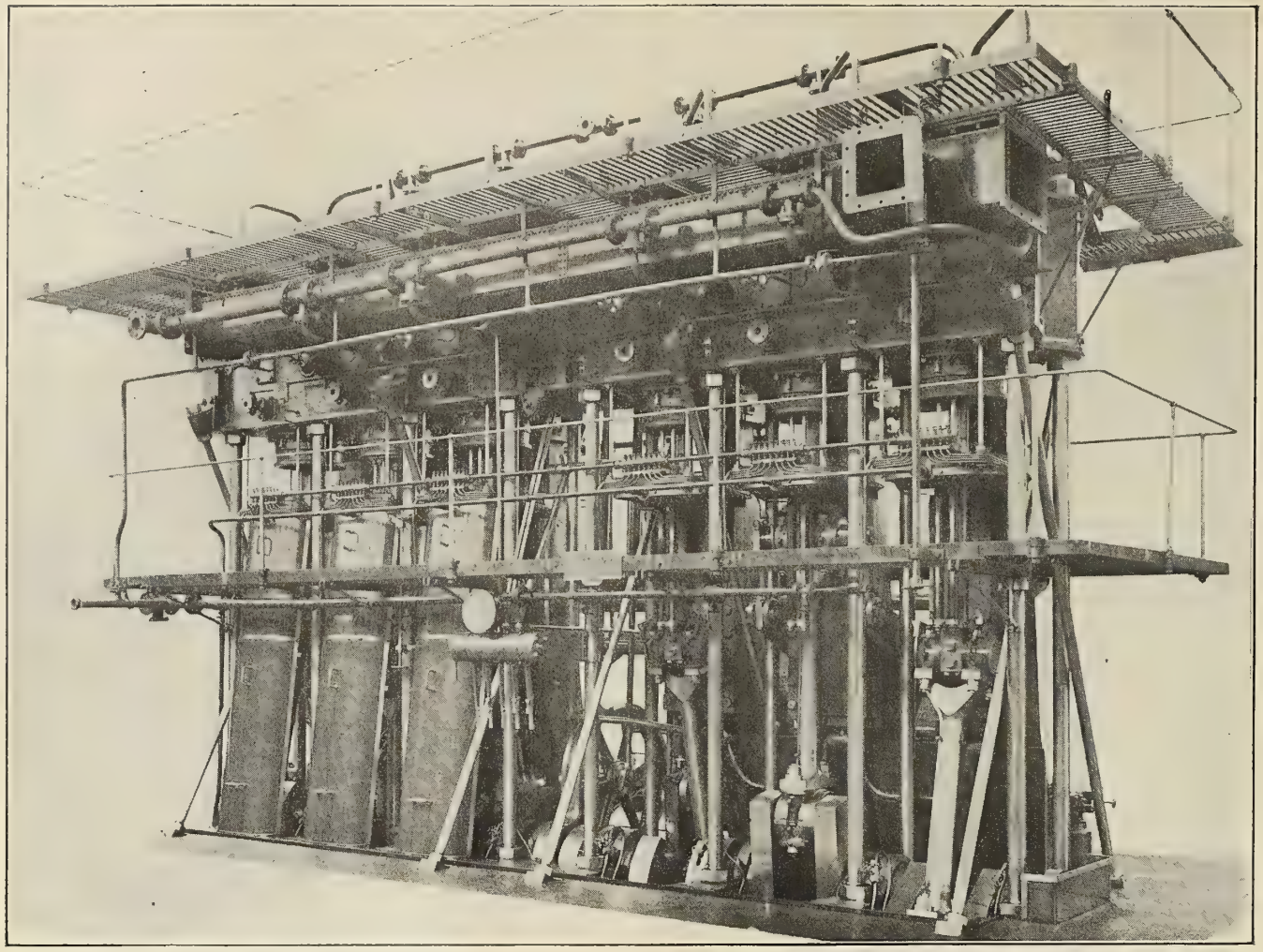


Fig. 1.—Werkspoor Marine Diesel Engine of 1,500 I. H. P. at 120 R. P. M.

The Werkspoor Marine Diesel Engine

Description of a Diesel Type Motor That Has Been Installed in Twenty-Two Sea-Going Commercial Ships

BY J. RENDELL WILSON

It is not generally known that the Werkspoor-Diesel engine since its inception has been installed in more ocean-going commercial ships than has any other make of Diesel engine, it having been installed to date in twenty-two vessels having a deadweight carrying capacity of over 40,000 tons and a total output of about 33,000 indicated horsepower. While many more Werkspoor-engined vessels are building, several of them are of only 250 to 500 brake horsepower, as the builders of the engine have preferred to develop the engine gradually instead of starting with high powers. Even after six years' experience with marine Diesels and fifteen years' construction of land Diesels, the Werkspoor Company has not to-day gone higher than 2,000 indicated horsepower per engine, although, of course, this does not apply to the near future.

One remarkable fact about the construction of high-powered Werkspoor marine engines is that all their recent ocean-going ships up to 3,000 horsepower per vessel in twin screws have had their motors installed directly into the hulls without even turning the engines over in the shops, not to say testing them on the brake, which was only done with the earlier engines. These motor ships merely receive a few hours' sea trial, and then are sent on twenty- and forty-days', non-stop ocean voyages. Many have gone to the Dutch East Indies, where they have remained in regular service.

Some technical details of the Werkspoor engine doubtless will be of interest, especially as it is the oldest of the sea-going Diesel engines, it having been installed in the Anglo-Saxon Petroleum Company's tanker *Vulcanus* in 1910, since when these owners have acquired eight other ships powered with the same make of motor.*

The engine illustrated, and which we propose to describe, is the 1,500-indicated horsepower model, which develops 1,100 brake horsepower at about 125 revolutions per

* When the Werkspoor Company first turned their attention to the marine Diesel engine, they decided that unless an engine can be repaired in any port of the world where steam engines can be repaired, it is of no use for ocean-going ships. To the present day they have adhered to this sound policy, consequently there is nothing fantastical about their design—in fact, from the bottom of the cylinders downwards it is exactly similar to an ordinary marine steam engine.

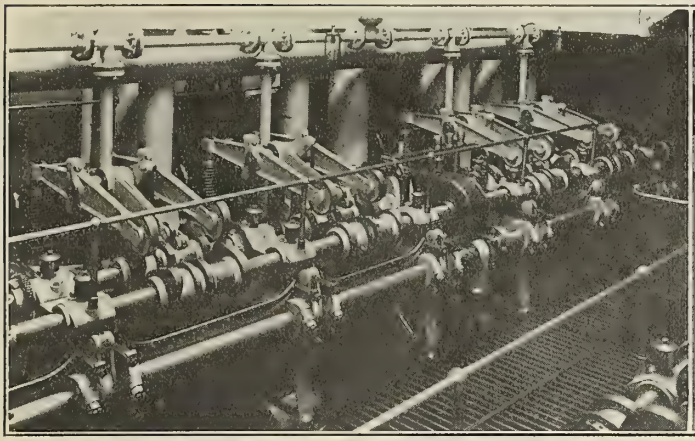


Fig. 2.—Valve Gear, Showing Ahead and Astern Cam Shafts

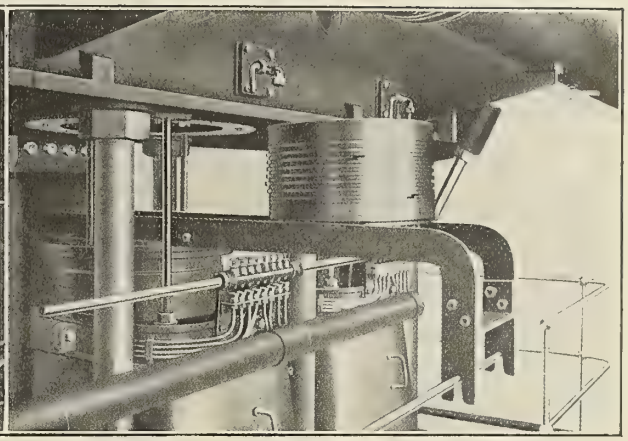


Fig. 3.—Method of Removing a Piston

minute from six single-acting cylinders, each 22 inches bore by 39⅜ inches stroke, and with a weight of about 122 tons. Its length is 27 feet 3 inches by 8½ feet width and 16 feet 9 inches high above the crankshaft. It will at once be noted that it is an engine in which accessibility has almost been brought to an unusual condition by reason of it being quite of the open crank-pit type, with the cylinders mounted on steel columns, etc., while strength and rigidity are added by steel cross-stays, with the cross-head guides on cast iron frames at the back of the engine. To the steel columns detachable steel plates are fitted to prevent the lubricating oil being thrown out by the connecting rods. The six working cylinders are divided into two sets of three, with the cam-shaft driving gear and all the control levers between.

One of the exclusive features of the Werkspoor design is to be found in the arrangement of the cam-shaft operating gear. At the back of the engine, just over the bed-plate, is a small lay crankshaft operated by two-to-one reduction spur-gearing off the main crankshaft. On this lay-shaft there are four crank-throws, and the motion is directly transmitted to similar crank-throws on the ahead cam-shaft (which is mounted in brackets on the side of the cylinder head) by means of four hollow, girder-shaped rods, and so the cam-shaft is given a gentle, even and continuous rotary motion, each throw being set at right angles to the others. These rods are really steel tubes, split down through the centers and held apart by cross struts, which, it is claimed, eliminate all vibration.

Now there are two cam-shafts, one for the ahead running and one for the astern movement, and the astern cam-shaft is driven by means of spur gearing from the ahead cam-shaft, while the two shafts are mounted on sliding brackets. When maneuvering, these brackets, by sliding to and fro as desired, bring the ahead or astern cams under the rollers of the valve-rockers. By making these rollers unusually large, the angle of the face of each roller where it meets its cam is never steep, and this produces smooth and silent running. Thus reversing is rapidly and quietly carried out. On ships in service the time occupied to reverse from full ahead to full astern is from five to ten seconds, this depending upon the smart-

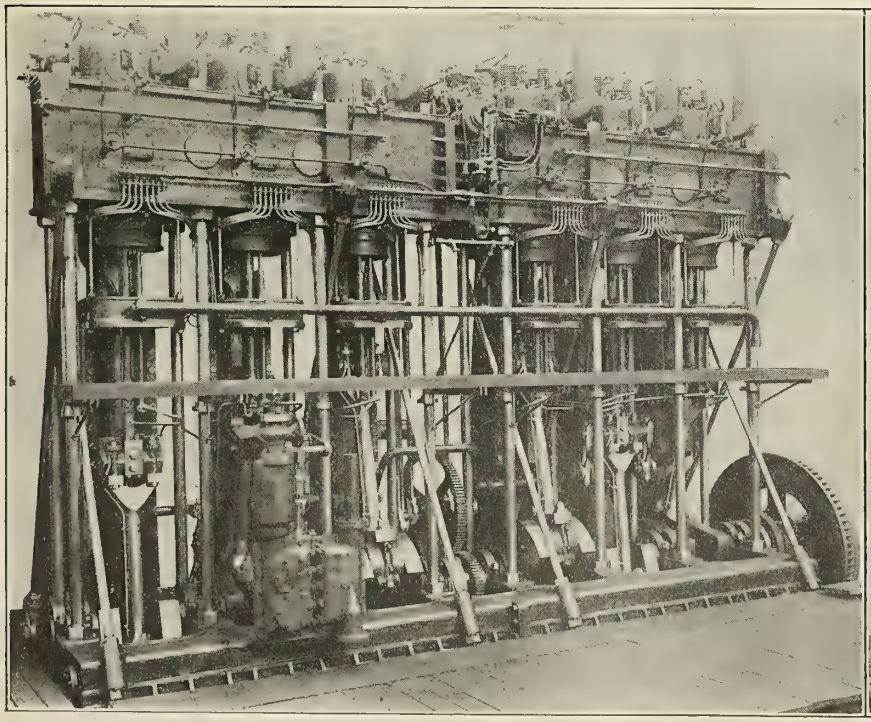


Fig. 4.—Back of Werkspoor 1,500 Indicated Horsepower Marine Diesel Engine, with Splash Plates Removed

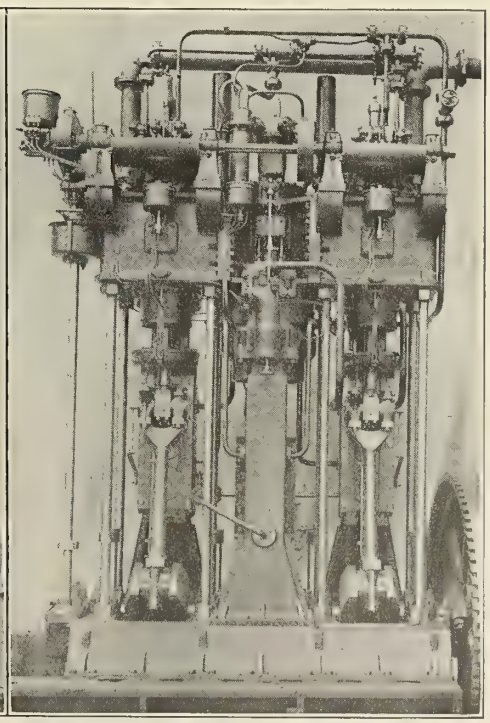


Fig. 5.—Werkspoor 2-Cylinder, 100-Horsepower Auxiliary Diesel Engine

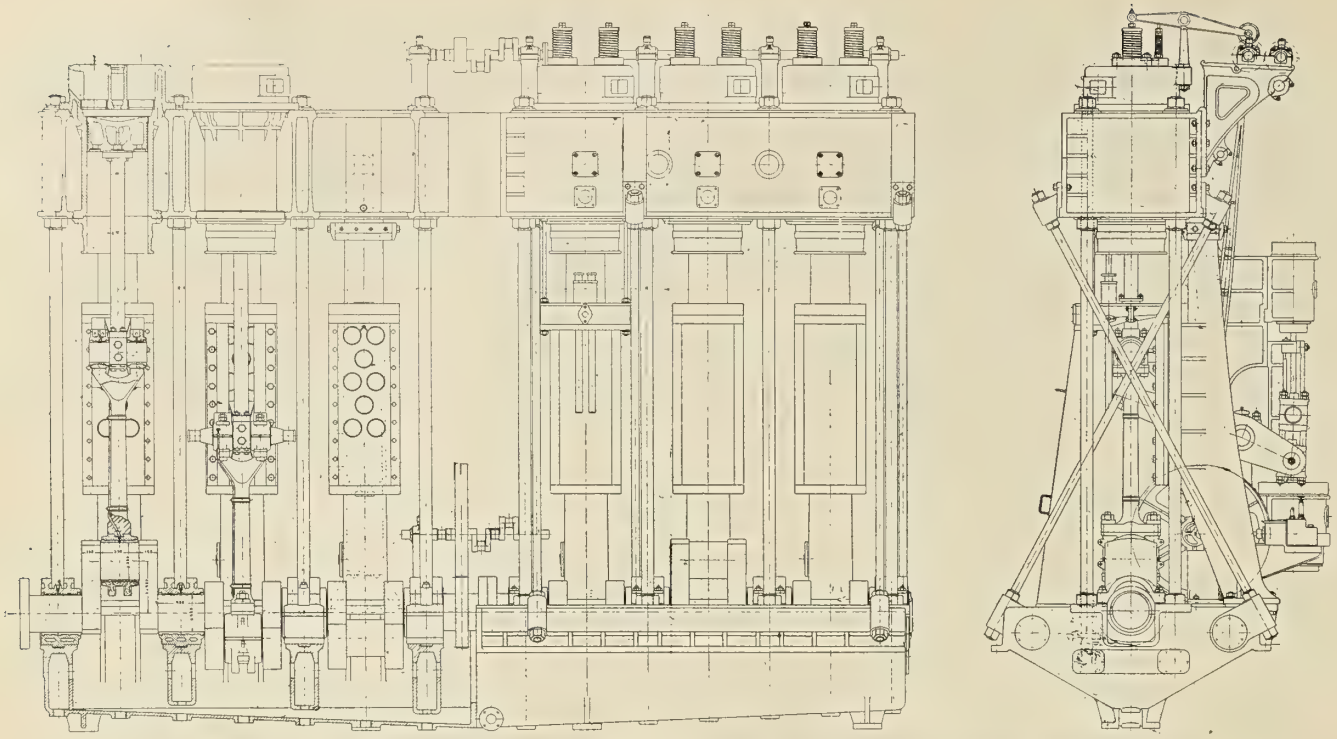


Fig. 6.—Plans of 1,500 Horsepower Werkspoor Diesel Engine, Showing Section Through Working Cylinder

ness of the engineer-in-charge. To start up from cold takes three to five seconds.

In view of the fact that the four coupling-rods would seem to require an arc for their lateral travel, unless they became buckled by the downward pressure, it is best to mention how the difficulty has been neatly overcome: the lower brasses are made with play and clear the pins when the two shafts are in the center of the chord; i. e., the mid-gear position, coming back into contact when the shaft is in the running position for either ahead or astern motion—the rods never push, but only pull.

Regarding the air-starting arrangements, it is interesting to note there are relief-valves fitted to the cylinders to reduce the compression internally; furthermore, there is a sleeve fitted to each air inlet pipe, so that the inlet can be closed and no atmospheric air admitted to the cylinders until the engine gets under motion. This sleeve is interlocked with the control gear. Thus this big engine can be started on a pressure of 250 pounds per square inch, which means great economy of compressed air, a very important point too often overlooked. The air-starting valve cam has a double "lift," one to allow of the valve being slightly opened, such as when the engine is hot, and does not require much air to get away under load. The larger "lift" can be brought into action should the engine be cold and refuse to pick up the load with a small quantity of air. To prevent sticking of the fuel valve there is a little automatic device, which closes it, should it happen to remain open by any chance.

Most Diesel engines have a separate fuel-pump to each cylinder, which are regulated by opening and closing the individual suction valves, and this method the Werkspoor firm considers requires too delicate an adjustment to supply exactly the same quantity of fuel to each cylinder, so they have fitted a single pump, which supplies two distributing boxes, each box having feeds to three cylinders, while every feed has its own adjuster. To the exhaust branch from each cylinder is fitted a thermometer, so that by reading the temperature the engineer can instantly see if any one cylinder is receiving more, or less, fuel than the others. As a standby an extra pump with a simple change-over device is fitted.

The fuel-pump does not supply the distributers direct, but first feeds a reservoir in which an air pressure is main-

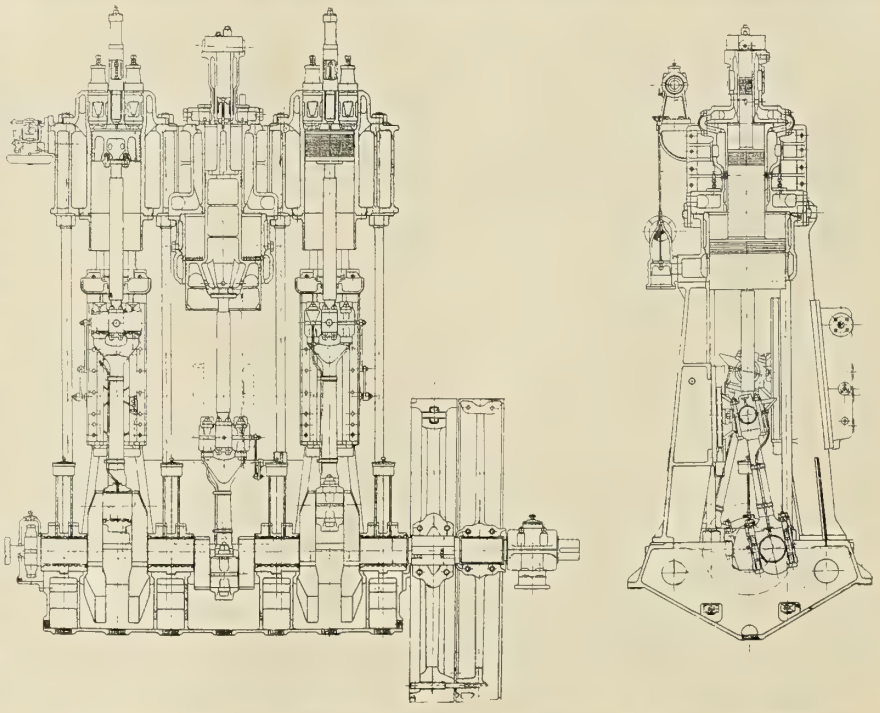


Fig. 7.—Two-Cylinder Auxiliary Engine. Air Compressor is Between the Working Cylinders

tained, thence the oil passes through a governor-controlled throttle, a hand throttle, and through master valves, and finally into the distributers. The receiver holds enough fuel to run the engine for 15 minutes, so that in case of a breakdown of the fuel-pump the spare pump can be connected up before the engine stops, which is not possible with any other design. The distributing boxes are quite close to the indicator cocks, so that adjustments may be made by the engineer in charge while he is reading the cards and thermometers, so accurate setting can be obtained. To ensure reliability, the plunger fuel-pump is made from a solid steel forging; the valves are simply steel balls, and the gland runs in an oil bath.

From the sectional drawing it will be noticed that the cylinder proper is separate from the outer jacket, which is a simple box-casting.

An important part of the design is that the cylinder liner which extends below the jacket is detachable, and may be unbolted, thus facilitating the easy removal of any piston without dismantling any portion of the engine, and so saving many hours of tedious labor. The pistons are water-cooled, this being carried out by means of clearance pipes and a pressure jet. Both these are exclusive and patented features.

Unlike the majority of Diesels, forced lubrication has not been adopted with the Werkspoor, and, except for the cylinders, the system used is entirely sight-drip-feed lubricators. To avoid overlubrication, light steel plates are fitted in front of the connecting-rods between the columns, to catch the splashes and direct them into the center sump of the crank pit, whence the oil is pumped through a filter and cooler on the engine-room walls, from which it is returned by gravity to the numerous sight feeds.

Regarding the three-stage air compressor, this is driven off the fifth cylinder by means of a link and beam lever on the crosshead at the back of the engine, and the water-cooling and bilge pumps are driven in a similar manner off the forward three cylinders. The after cast iron column is utilized as a cooler for the air compressors, the air circulating through water-cooled coils contained therein. A relief valve is fitted to the column to prevent damage should one of the coils burst, and at the top of the column there is a water overflow valve.

Thus it will be seen that the Werkspoor design is self-contained and does not require a large amount of separate Diesel-driven auxiliary machinery to run the engine, particularly as the exhaust gases are led to a donkey boiler, and sufficient heat is obtained to maintain a pressure of 100 to 120 pounds when at sea, and thus economically operate the auxiliaries. Yet the engine of the *Juno* (which is similar to those installed in the *Emanuel Nobel*, *Elbruz* and *Siberg*, only the latter two ships have modern improvements added to their engines) gave 1,460 indicated horsepower at 115 revolutions per minute, or 1,140 brake horsepower with a mechanical efficiency of 78 percent, the mean effective pressure being about 105 pounds per square inch. Some of the cards have shown a mean effective pressure of 126 pounds per square inch.

Although often termed crude oil, very little fuel of this nature is used by Diesels, owing to the presence of the light carbons, but what is really used is residual oils; that is to say, the oil after the gasolene (petrol), kerosene (paraffin), etc., have been extracted. But the *Juno* and *Vulcanus* have successfully run on Taraken, which is crude oil, with a specific gravity of about 0.94. The general consumption of Werkspoor-engined ships in service has been about 0.30 pound per indicated horsepower hour.

The fuel question is, however, a most important one. Very heavy oils can be successfully used, but under such conditions a lighter fuel, such as Solar oil, must be used for starting, and for about 15 minutes each day the engine should be run on the lighter oil, in order to clean the fuel injection valves and combustion chambers. At the same time where the lighter grades of fuel oils can be obtained at about the same cost as the very heavy oils, their use is advised by the makers, as it is foolish to use oil full of foreign matter and so thick that it has to be heated before it will follow the stroke of the fuel pump.

To illustrate what a Diesel engine can consume, we may add that at the Werkspoor works a test motor ran without trouble and for a considerable period on Mexican crude oil of the following analysis:

Specific gravity at 15 degrees C	.862
Flash point (closed test)	140 degs. F.
Calorific value	17,430 B. T. U.
Sulphur	4.6 percent
Asphaltum	70.0 percent

This, of course, is an exceedingly heavy oil. It was only successfully used under the most favorable conditions, and the Werkspoor Company would be the last to advise its use under average seagoing conditions. Contrary to the general impression, the presence of sulphur in the oil does not cause an ill effect on the exhaust valves and cylinders, provided, of course, proper care is taken.

Lastly, we will say that we have been advised that none of the Werkspoor-engined ships placed in service during the last year or two has suffered from cracked cylinders or cylinder heads, which is, perhaps, a pleasant revelation. Naturally, with the earliest ships some trouble was experienced from this cause, but the makers were enabled to discover the reason for the cracks, and a change in the design entirely eliminated the difficulty. Recent ships have proven themselves to be thoroughly reliable. It is only fair to add that even the cracks that arose with earlier engines did not prevent the engines from continuing working without new cylinders, so that, while the Werkspoor Company afterwards changed such castings, it was not really necessary.

CONNECTICUT RIVER IMPROVEMENT.—Federal improvements of the Connecticut River from Hartford, Conn., to Holyoke, Mass., to provide a 12-foot channel at a cost of $1,870,000 (£384,000) have been recommended to Congress by the Army Engineering Board. The construction is conditional upon the construction of terminals at Hartford, Holyoke and Chicopee, and also upon the construction of a lock at Enfield by private interests.

OFFICERS OF THE NATIONAL BOARD OF STEAM NAVIGATION.—At the annual meeting of the National Board of Steam Navigation, held in Washington in December, E. F. Moran, New York, was elected president; J. Frank Tilley, Pittsburgh, first vice-president; W. E. Bernard, Philadelphia, second vice-president; E. A. Burnside, Point Pleasant, W. Va., third vice-president, and Captain N. L. Cullin, New York, secretary-treasurer.

NEW SWEDISH SHIPYARD.—According to press reports a large new shipbuilding yard is to be established at Landskrona by a Gothenburg firm. Between 600 and 700 men will be employed and the municipality has agreed to carry out the preliminary excavations at a cost of $102,600 (£21,000).

SWEDEN PROHIBITS THE SALE OF VESSELS.—The Swedish government has prohibited the sale of Norwegian vessels to any foreign country, although the law may be waived in special cases.



(From The Commercial Vehicle)

Fig. 1.—A Typical Line-up at One of the New York City Piers. Note Light Electric Motor Trucks in Right-hand Background, waiting with the Rest. Attitudes of Drivers Tell a Story in Themselves

Motor Trucks as the Solution of the Marine Freight Terminal Problem

Savings in Time and Costs Made Possible by Use of Motor Trucks at Marine Terminals—Congestion of Freight

BY MERRILL C. HORINE *

Four-fifths of the cost of freight transportation in the United States represents terminal charges. It costs less to ship a ton of freight via water from Savannah to New York than to transfer it from the vessel's hold to a Brooklyn warehouse, inland. The business of the carrier is to transport merchandise, which nearly all of them do with astonishing efficiency and at surprisingly low cost.

The present freight tie-up in America arising from heavy export shipments occasioned by the war proves that the business of the carrier also includes terminal work and that without corresponding efficiency in this branch of its work, that of the other and chiefest work goes for little.

Of what avail is it that a company be prepared to transport a cargo quickly, safely and cheaply if it cannot get that cargo without vexatious and costly delay? The carrier's business begins when he receives the goods at his terminal, and ends when it is carted away from its other terminal.

Modernize terminal and street transportation having a direct connection with marine transportation and your problem is solved. The most modern and efficient means of short-distance transportation to-day is the commercial motor vehicle.

To appreciate the bearing of the motor truck on the marine-freight-terminal problem it is first necessary to consider the relation of the motor truck to present freight-carrying appliances.

There are approximately 2 million freight cars in service on American railroads. These freight cars haul annually about 2 billion short tons an average of 137.5 miles or 275 ton-miles per year. Of this enormous tonnage, a portion goes to make up the annual freight tonnage of ocean vessels into and out of United States ports—approximately 600 million tons annually, or one-third.

This third represents, then, the total tonnage of merchandise handled by marine freight terminals in this country. As such it also represents what is handled under the most adverse circumstances, for our marine terminals are the ones where the greatest volume of matter has to pass over a given area of platform in a given time.

A steamship is unloaded, coaled and provisioned and then reloaded in the minimum possible time because of the tremendous investment represented by the vessel, which is entirely wasted every hour it stands idle. A vessel is only earning when it is transporting goods, and for this reason every possible means is, or should be, used to speed up the loading and unloading operations. It costs between $40 and $45 (8/6/8 and 9/7/6) an hour to hold the usual size of coastwise steamship in port. This is not only indicative of the occasion of the great traffic over steamship bulkheads in a short time, but also of the importance of using every means possible to avoid delay at the terminal.

There are not much over 120,000 motor trucks of all classes in use in this country, and not any great proportion of these are used in connection with freight-terminal

* Associate editor of *The Commercial Vehicle.*

24179

work. To handle all of the 600 million tons which annually pass over the marine bulkheads—2 million tons every day of a working year of 300 days—would require about 20,000 motor trucks, working at their maximum ability. But a great portion of this freight never reaches the street; it is transferred directly to freight cars, lighters or warehouses.

Of 2 billion tons of freight handled annually by the railroads, 120 millions are package freight, or less carload lots (l. c. l.). Assuming the same proportion of bulk to l. c. l. freight to hold good in marine freight, then one-sixth of the total marine freight per day, or 333,333 tons daily, must be taken away from marine terminals by street vehicles. Thus only 3,333 motor trucks, or we will say, allowing for an adequate reserve, 3,500 will be required to accomplish this work.

This contemplates a daily tonnage of close to 100 for each truck. If the average haul is 2.5 miles each way and the average speed throughout the day 5 miles per hour and the loads approximately full in both directions, this would be realized, 10 tons being transported each of ten trips per day.

Perhaps it may be a point for legitimate doubt if a motor truck could rise to such astonishing effectiveness under present conditions of traffic in New York, Boston or Philadelphia, but investigation will disclose that the present inability of motor trucks to even approximate such a performance is due not so much to street-traffic conditions as to loading and unloading delays encountered.

It is necessary to estimate the work of motor trucks under an ideal terminal transport scheme because the number at present used in such work is negligible.* We have a good basis to work on, however, in determining the efficiency of horses. A horse dray with a two- or three-horse team carries about 4 tons in a city of average grades. It can travel a maximum of 15 miles per day with good

* Investigations conducted by the author have shown that in the fall of 1912 motor trucks constituted 3 percent of the trucking from Chicago freight terminals. In New York, in the summer of 1913, 7 percent of the freight terminal traffic observed was by motor.



(From The Commercial Vehicle)

Fig. 3.—Why the Wagons Must Wait. Here the Goods are so Congested Within the House That There is No More Room to Unload, so That It Takes Abnormally Long for Each Vehicle to Discharge Its Load and Get Away, Meanwhile Delaying Others

loading and unloading conditions. But, with these as they actually are, horse wagons in this service make but 9 miles average per day, or about two trips. Also, at present, they do not as a rule carry full loads, the average being about half the capacity of the vehicle, outbound freight being slightly more than this, and inbound correspondingly less.*

Thus, with a 2-mile to 2.5-mile haul, each wagon will haul some 4 tons per day in each direction, or 8 tons daily. However, the load factor, too, is very poor, the outbound load being generally much less than the inbound load, so that perhaps each wagon will not average over 6 tons daily. Thus, to handle the 333,333 tons of matter would require 55,555 drays, or, allowing for a reasonable reserve, 60,000, and 120,000 to 130,000 horses.

* Based on investigations in Boston by Harold Pender, H. F. Thomson and H. F. Eldred, for the Massachusetts Institute of Technology, and presened before the New York Railroad Club, September 18, 1914.



(From The Commercial Vehicle)

Fig. 2.—A Clear Platform on An Efficiently-Conducted Pier (The Fall River Line, Pier 14, New York City). Electric Industrial Trucks Take All Freight Away From the Narrow Platform As Soon As It Is Unloaded and Checked. Usually They Take It Directly Into the Vessel's Hold and Stow It. Almost No Waiting Here in Spite of Great Traffic and Limited Quarters

Contrasting 60,000 two-horse wagons with 3,500 trucks it will be seen that were conditions changed so that motor trucks could be used efficiently, 56,500 vehicles would be saved. Where this touches the terminal engineer is first, in the space saved. An ordinary 5-ton truck is, roughly, 20 feet long and requires a 9-foot roadway. A 4-ton dray, with its team, is 25 feet long over all, and should have a 10-foot roadway to allow for the erratic movements of the animals. The truck occupies 180 square feet; the dray, 250. The difference is 70 square feet.

Pier rental on the west side water front of business, New York, is about 80 cents (3/4) per square foot.

Suppose that instead of adopting motor trucks for terminal trucking, assuming that it is possible to make the change, terminal facilities were so improved by the use of cranes, telphers and electric industrial trucks that horse wagons might also work to their full efficiency. Then each wagon could make three trips instead of two, totaling 15 miles—the limit of the practical endurance of the animal. It would transport 4 tons each way or 8 tons round trip, thus totaling 24 tons daily. What advantage would there be for the carrier, the steamship company?

Considerable. There would be one-fourth less vehicles to deal with, therefore less space would be occupied at any one time. Loads would be greater, and therefore fewer, for a given volume of freight, and less clerical work would be involved. But matters would not remain at this state for long, for the horse only pays when circumstances are such that he must work inefficiently. As soon as you work a horse at his highest pitch, there is a man with a motor truck who is ready to do the job better, more quickly and at less cost.

Motor trucks are little used to-day in freight-terminal work because they cannot realize their latent powers. The work is much like that for which towed barges and car ferries are used in preference to steam vessels.* Many concerns have tried to apply motor trucks to their freight shipping and receiving work, and have given it up,** and it is pretty generally accepted now among shippers that wherever else the motor truck may be able to oust the horse, it cannot compete with him in freight-terminal work.

Not until loading and unloading conditions change for the better can motor trucks be successfully operated in this class of work. Perhaps if the carriers realized the advantages which would accrue to reform of terminal methods more of an effort to change them would be made. Let us say that each motor truck occupies 70 square feet less space than a horse wagon and that each truck displaces four horse drays. Then each truck would save 280 square feet. An average downtown North River pier in New York accommodates from 200 to 300 vehicles daily. This number could be doubled under an efficient motor trucking scheme, and still congestion would be reduced 100 percent. A line with a fixed volume of business could share its pier with another similar line, thus cutting its rental in two.

Of course, much of the rental space is devoted to the storage of goods awaiting loading or carting away by teams. This space would also be less, however, because with a reduction of congestion and an increase in efficiency the goods would move more quickly. Knowing that immediate access to their consignments could be had at all times, merchants would in all likelihood make more of an effort to get them sooner, and would also not deliver goods for shipment until shortly before the vessel was ready to load.

But the carriers cannot work alone in this. They cannot force shippers and shippers' agents to employ motor trucks. They cannot require them to distribute the work more evenly through the day to avoid congestion-augmenting peak loads. They can, however, afford better physical conditions in their terminals.

It costs but 2 cents (0/1) to unload a vessel, as against from 25 to 35 cents (1/0½ to 1/5½) in some instances to subsequently handle it between the time it is raised from the hold until it is deposited at the merchant's door.

It has often been urged that the carriers adopt the system employed by the express companies, who call for and deliver shipments direct from and to the doors of shippers and receivers of goods. These companies operate motor trucks extensively and under a much higher load factor than is the case with freight-transfer vehicles. This is because the consignments of several parties are delivered together on one trip and several collections of goods made on the same return trip.

This practice is long established abroad, especially in England, where the practice has existed practically since the inception of modern freight-carrying means. In some cases separate cartage concerns are licensed by the carriers or by a number of carriers, for this work, and the method is entirely satisfactory to both carriers and their customers.

It is not altogether an untried experiment in this country. It was done by the Baltimore & Ohio Railroad in Baltimore, and was highly successful, but was discontinued because the Interstate Commerce Commission would not permit the absorption of the charges in the freight tariffs, as they are in express rates, and a separate charge was found impracticable. The New York, New Haven & Hartford Railroad employs a fleet of electric motor trucks for the transfer of freight between different terminals. In Chicago the Illinois Tunnel Company has done not only l. c. l. transfer work, but has made deliveries to large department stores, etc., as well.

In an investigation conducted by David Beecroft, William B. Stout, H. A. Tarantous and the writer in Chicago during the summer of 1912 and presented before the National Association of Automobile Manufacturers, in Detroit, November 14, 1912, the statement of J. F. Barron, freight agent of the Illinois Central Railroad, was quoted to show that it is worth while for the carriers to make motor truck use practicable:

"If motor trucks were used exclusively at six of the big railway terminals of Chicago for bringing freight to the depots and taking it away from these depots the work could be done in one-half the time at present required and at one-third the cost.

"This would mean a saving in Chicago transportation at these six depots of $4,320,000 (£886,000) per year."

Increasing freight terminal efficiency is worth while. It is possible. It will save money for all concerned. It is necessary.

* In an investigation made in New York by the author and associates in the summer of 1913 it was found that the average wait before loading at the North River inbound docks was over one hour, and that only 58 percent of the vehicles which waited in line, some as long as two hours, got onto the pier at all.

** The Loose-Wiles Biscuit Company, Long Island City, N. Y., has been using some 3 ton gasoline (petrol) trucks in freight terminal hauling, and finds that only two trips per day are possible in a nine-hour day, on an 11-mile haul from Manhattan docks. This is exactly twice the work of an ordinary horse dray, while the cost must be considerably higher. The length of haul would seem to indicate that here was a favorable opportunity for motor haulage, but the long delays at the freight wharves have made any such expectations unrealized.

NEW MAGAZINE FOR STEAMSHIP INTERESTS.—Steamship companies of New York have started a new magazine, called the *Funnel*, the object of which is to promote friendly intercourse among the steamship men of the port. Members of the management and editorial staff have been chosen from the Atlantic and coastwise companies. Edmund Dwyer is editor of the new publication.

Shipbuilding Revival in the United States

Unprecedented Demand for American-Built Ships Fills Sea Coast Yards—Over 700,000 Tons of Merchant Vessels Now Building

For the first time in many years American shipyards are filled practically to capacity with new work, with every indication that this satisfactory condition will continue for many months to come.

According to reports sent to this office from practically every shipyard in the country, there are at the present time over 200 large merchant vessels, totaling about 700,000 gross tons, under construction.

In addition to the merchant work, there are in private shipyards about 59 government vessels under construction, aggregating 168,152 tons displacement, while, in addition to that, there are also building in the government navy yards 12 vessels, aggregating 176,010 tons displacement, making a total of 71 government vessels of 344,162 tons displacement now building in the United States.

The above figures, however, do not include the tonnage of 40 submarines, 11 of which are building for foreign navies, as the particulars of submarine vessels have not been officially disclosed.

Of the merchant vessels now under construction, 116 of 643,475 gross tons are large sea-going vessels, mostly over 3,000 tons. Thirteen are over 10,000 tons each, 26 range from 7,000 to 10,000 tons, 27 from 5,000 to 7,000 tons, 10 from 4,000 to 5,000 tons, and 42 from 2,000 to 4,000 tons.

The vessels now building may be classified as follows: oil tankers, 48 of 343,851 gross tons; freighters, 53 of 228,041 gross tons; colliers, 9 of 39,855 gross tons; passenger and freight steamers, 6 of 31,728 gross tons.

Output of Shipyards in 1915

During the year 1915 the aggregate tonnage of large sea-going merchant vessels built in the United States was less than has been the case for several years. Taking into account only vessels over 100 gross tons, there were built during the year 129 sea-going merchant vessels, aggregating about 173,223 gross tons. In addition to the merchant vessels, 18 government vessels, aggregating 48,146 tons displacement were completed.

Of the sea-going merchant vessels built in 1915, 2 were over 10,000 tons; 4 were between 7,000 and 10,000 tons; 10 were between 5,000 and 7,000 tons; 2 between 4,000 and 5,000 tons and 6 between 3,000 and 4,000 tons.

Classified according to types, the output was as follows: Freighters, 19 of 62,039 gross tons; colliers, 6 of 38,410 gross tons; oil tankers, 5 of 33,238 gross tons; passenger and cargo steamers, 10 of 15,014 gross tons; and oil barges, 9 of 3,963 gross tons.

Although the figures for the output in 1915 are exceptionally low, they reflect the conditions in the American shipyards a year ago rather than at the present time. During 1914, scarcely any contracts of importance for merchant vessels were placed with American shipbuilders, and consequently deliveries of vessels in 1915 have been exceedingly few in number.

Early in 1915, however, the oil companies began to place orders for large oil tankers and these were soon followed by orders from other steamship companies for large freight-carrying steamships. With this impetus, shipyards have rapidly filled up with new work until now, in spite of the fact that almost every ship owner is in the market for new tonnage, it is practically impossible to place contracts for large merchant vessels on the sea coast for delivery inside of twenty-four months.

In this unprecedented demand for American-built ships, the oil companies have been the leaders, and at the present time approximately one-half of the tonnage of merchant vessels under construction is composed of oil tank steamships.

As shown in Tables I and II, which give the number, tonnage and horsepower of both merchant and government vessels built in 1915, and also the number, tonnage and horsepower of vessels now under construction in the leading shipyards of the United States, it will be seen that the greatest output of merchant tonnage in 1915 was from the Maryland Steel Company, Sparrows Point, Md., with the New York Shipbuilding Company, Camden, N. J., second in the list. Including government vessels, the largest total output for 1915 was from the New York Shipbuilding Company.

At the present time, the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., has in hand the greatest amount of tonnage under construction, with the New York Shipbuilding Company a close second.

TABLE I.—MERCHANT CONSTRUCTION

Ships Built in 1915

	No.	Gross Tons	I. H. P.
Maryland Steel Company	6	38,956	24,900
New York Shipbuilding Company	7	29,331	13,400
Fore River Shipbuilding Corporation	2	15,000	6,000
Union Iron Works	3	11,951	5,000
Newport News Shipbuilding & Dry Dock Company	3	11,837	4,900
Great Lakes Engineering Works	10	9,603	4,894
American Car & Foundry Company	14	7,864	....
Southern Pacific Company	2	7,655	8,500
Harlan & Hollingsworth Corporation	4	7,264	11,397
American Shipbuilding Company	1	7,180	2,400
American Bridge Company	36	7,090	....
Kelly-Spear Company	3	4,862	....
Staten Island Shipbuilding Company	6	3,154	3,250
Manitowoc Shipbuilding & Dry Dock Co.	5	2,122	1,600
Baltimore Dry Docks & Shipbuilding Co.	3	1,632	650
Johnston Brothers	3	1,192	450
W. & A. Fletcher Company	1	1,080	1,500
Percy & Small	1	898	....
Anderson Steamboat Company	2	893	1,350
Toledo Shipbuilding Company	2	720	....
Dubuque Boat & Boiler Works	5	700	900
F. S. Bowker & Sons	1	567	....
Bath Iron Works	1	471	325
Wm. Cramp & Sons Ship and Engine Building Company	4	421	1,750
Charles Barnes & Co.	1	300	200
George Lawley & Sons Corporation	1	270	500
The Pusey & Jones Company	2	210	250

Merchant Vessels Now Under Construction

	No.	Gross Tons	I. H. P.
Newport News Shipbuilding & Dry Dock Company	16	120,399	43,400
New York Shipbuilding Company	22	107,639	38,070
Wm. Cramp & Sons Ship and Engine Building Company	13	71,500	46,400
Union Iron Works	10	69,240	30,800
Harlan & Hollingsworth Corporation	13	58,162	41,352
Maryland Steel Company	10	54,084	24,400
American Shipbuilding Company	12	49,100	18,000
Fore River Shipbuilding Corporation	7	49,000	21,200
Great Lakes Engineering Works	11	31,347	13,975
Toledo Shipbuilding Company	7	20,000	4,000
Baltimore Dry Docks & Shipbuilding Co.	4	14,000	7,200
American Bridge Company	35	12,223	....
Chester Shipbuilding Company	2	11,600	6,000
Seattle Construction & Dry Dock Co.	2	7,800	5,000
Kelly-Spear Company	5	3,380	....
American Car & Foundry Company	4	2,744	....
The Pusey & Jones Company	7	2,320	1,150
Staten Island Shipbuilding Company	7	1,908	4,050
G. G. Deering Company	1	1,900	....
Manitowoc Shipbuilding & Dry Dock Co.	4	1,880	1,650
Johnston Brothers	2	800	....
Percy & Small	1	800	....
Charles Barnes & Co.	2	720	400
F. S. Bowker & Sons	1	567	....
Ellicott Machine Corporation	3	540	1,950
Bath Iron Works	1	418	7,000
Anderson Steamboat Company	1	360	500
Dubuque Boat & Boiler Works	2	85	105

TABLE II.—GOVERNMENT CONSTRUCTION

Vessels Built in 1915

	No.	Tons Displacem't	I.H.P.
New York Shipbuilding Company	4	35,296	87,270
Seattle Construction & Dry Dock Co.	1	3,580	....
Wm. Cramp & Sons Ship & Engine Building Company	3	3,120	51,000
Newport News Shipbuilding & Dry Dock Company	2	1,800	2,000
Ellicott Machine Corporation	2	1,100	1,250
Fore River Shipbuilding Corporation	1	1,050	16,000
Bath Iron Works	1	1,040	15,000
Spedden Shipbuilding Company	2	620	560
Hall Bros. Marine Railway & Shipbuilding Company	2	540	800

Government Vessels Now Under Construction

	No.	Tons Displacem't	I.H.P.
New York Shipbuilding Company	5	63,450	101,500
Newport News Shipbuilding & Dry Dock Company	2	63,400	63,000
Fore River Shipbuilding Corporation	*24	30,842	77,000
Wm. Cramp & Sons Ship & Engine Building Company	3	3,290	54,000
Bath Iron Works	3	3,235	52,000
Craig Shipbuilding Company	†9	1,750	1,500
Manitowoc Shipbuilding & Dry Dock Co.	1	1,100	1,000
Seattle Construction & Dry Dock Co.	‡4	1,085	20,000
Lake Torpedo Boat Company	§8	....	....

Shipbuilding on the Atlantic Coast

The output of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., for 1915 consisted of the two Coast Guard cutters, *Ossipee* and *Tallapoosa,* of 900 tons displacement and 1,000 horsepower each, a freighter of 3,063 gross tons and 1,500 horsepower for the New York & Porto Rico Steamship Company and two freighters of 4,387 gross tons and 1,700 horsepower each for the Crowell & Thurlow Steamship Company. The battleship *Pennsylvania* was launched in 1915 and was about 93 percent complete at the end of the year. The only other government vessel that is under construction at the Newport News yard is the battleship *Mississippi.* The list of merchant vessels building, however, includes eight oil tankers, six for the Standard Oil Company and one each for the Southern Pacific Company and the Atlantic Refining Company. Four of the Standard Oil ships are of 10,900 gross tons and 3,000 horsepower each. A freighter of 8,000 gross tons is under construction for the Luckenbach Steamship Company, a freight and passenger ship of 6,000 gross tons for the Mallory Line, two freighters of 4,600 gross tons each for the Munson Line, two freighters of 5,900 gross tons each for Crowell & Thurlow Steamship Company, and two freighters of 4,500 tons each for the Southern Pacific Company.

Two destroyers and the destroyer tender *Melville* were devlivered to the United States Navy Department by the New York Shipbuilding Company, of Camden, N. J., during 1915, as well as the battleship *Moreno* for the Argentine Government. The output of merchant vessels at this yard during the year consisted of a lumber steamer of 5,483 gross tons for the Carpenter-O'Brien Company, the oil tanker *Gulfcoast* of 5,188 gross tons for the Gulf Refining Company, two colliers of 5,266 gross tons each for the Coastwise Transportation Company, two colliers of 3,289 gross tons each, one for the Harby Steamship Company and the other for the Pocahontas Navigation Company, and the dipper dredge *Cascadas,* of 1,550 gross tons, for the Isthmian Canal Commission. The machinery of all of the merchant vessels consisted of Scotch boilers and triple expansion reciprocating engines, while the government vessels were engined with either Curtis or Parsons turbines and watertube boilers of either the Babcock & Wilcox or Thornycroft types. The destroyer tender *Melville* was equipped with Parsons turbines and reduction gear.

The work now under construction at the yards of the New York Shipbuilding Company includes two destroyers and the battleships *Oklahoma* and *Idaho* for the United States Navy; four oil tankers of 10,250 gross tons each for the Standard Oil Company, an oil tanker of 10,250 gross tons for the Petroleum Transport Company; two oil tankers for the Gulf Refining Company, one of 10,250 gross tons and the other of 5,188 gross tons; two colliers for the Coastwise Transportation Company and two for the Pocahontas Navigation Company, the former being of 4,015 gross tons and 5,266 gross tons respectively, and the latter of 3,289 gross tons each. There are also three colliers, two of 5,266 gross tons and one of 8,500 gross tons, building for the Darrow-Mann Company, and eight car floats of about 750 gross tons each for the New York, New Haven & Hartford Railroad Company. Except for the naval vessels, the machinery for these ships consists of Scotch boilers and reciprocating, triple or quadruple expansion engines.

With the exception of the steam yacht *Whileaway,* of 421 gross tons, equipped with Parsons turbo-reduction gear machinery and White-Forster watertube boilers, built for Mr. Harry Payne Whitney, the whole output of the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., for the year 1915 consisted of government work, including three destroyers and three scows for the Panama Canal. This yard now has under construction five destroyers for the United States navy, and seven oil tankers, five of them being of 7,100 gross tons (two for the Sun Company, two for the Petroleum Transportation Company and one for the Petroleum Oil Company). The other two oil tankers are of 2,800 gross tons for the Mexican Navigation Company. The Cramps yard also has under construction three freighters of 6,300 gross tons each for W. R. Grace & Co.; two passenger and freight vessels of 4,400 gross tons each for the Atlantic Gulf & West Indies Steamship Company, and a car ferry of 2,700 gross tons for the Florida East Coast Railway.

The output of the yards of the Harlan & Hollingsworth Corporation, Wilmington, Del., for 1915, consisted of an oil tank steamship of 5,605 gross tons for the Shell Company of California; a twin screw ferryboat of about 1,330 gross tons for the Fort Lee Ferry Company, New York; an oil barge for the Commercial Company, and a small twin screw car ferry for the Bethlehem Steel Company. A large number of boilers were also built for installation in vessels built elsewhere. In common with the other Atlantic coast yards, the work now in hand at this plant consists largely of oil tank steamships, two of 5,605 gross tons being under construction for the Shell Company of California; three of 5,800 gross tons and one of 8,490 gross tons for the Standard Oil Company of New Jersey; one of 5,347 gross tons for the Petroleum Transport; one of 2,750 gross tons and another of 5,605 gross tons for the Vacuum Oil Company. A coastwise freight steamer of 2,010 gross tons is under construction here for the Baltimore & Carolina Steamship Company, a freight and passenger steamship of 4,500 gross tons for the Ocean Steamship Company and another of 750 gross tons for the Wilmington Steamboat Company, as well as a Diesel-engined 96-foot motor yacht for Mr. William G. Coxe, president of the Harlan & Hollingsworth Corporation.

In the marine department of the Maryland Steel Company, Sparrows Point, Md., which turned out the largest volume of merchant tonnage in 1915, the output consisted of two colliers of 10,650 gross tons for the Panama Canal, two freight steamers of 3,628 gross tons each for A. H. Bull & Co., a freighter of 6,600 gross tons for the Ameri-

* Includes twenty submarines, details of which are withheld. Ten are for Great Britain and one for Spain.

† Eight are submarines for the United States Navy, details of which are withheld.

‡ Three are submarines for the United States Navy, details of which are withheld.

§ All are submarines for the United States Navy, details of which are withheld.

can-Hawaiian Steamship Company, and a passenger and freight steamer of 3,800 gross tons for the Munson line. In addition to two oil tankers of 10,000 tons each for the Standard Oil Company, this yard now has under construction two freighters of 5,800 gross tons each for the American-Hawaiian Steamship Company, three freighters of 3,628 gross tons each, two of which are for the Munson line and the other for A. H. Bull & Co., and two freighters of 3,800 gross tons for the Bull Insular line.

The Fore River Shipbuilding Corporation, Quincy, Mass., has had under construction during the past year a large amount of government work, including four destroyers, one of which was delivered in 1915, nine submarines for the United States navy, including the fleet submarine *Schley,* one submarine for the Spanish government, and ten others for the British navy. The list of merchant vessels building at the Fore River yard includes four tank steamers of 7,500 gross tons and 3,000 horsepower each for the Texas Company, three molasses steamers of 5,000 gross tons and 2,400 horsepower each for the Cuba Distilling Company, and two cargo steamers of 9,500 gross tons and 4,000 horsepower each for the Luckenbach Company. The United States battleship *Nevada,* which is being built by this company, has already run her trials and is nearly complete.

In Baltimore, the Baltimore Dry Docks & Shipbuilding Company delivered in 1915 to the Huasteca Petroleum Company two oil barges, one of 564 gross tons and the other of 318 gross tons, and to the United States War Department a sea-going suction dredge of 750 gross tons. Four bulk oil tankers of 3,500 gross tons and 1,800 horsepower each are now under construction by this company for a Norwegian firm, the Trans-Atlantic Motor Ship Company. These vessels will each be equipped with three Bolinders engines of 600 brake horsepower each.

The Ellicott Machine Corporation of Baltimore delivered two hopper dredges, of 450 and 650 gross tons respectively, for the United States government, and now has under construction three tugs for the Pennsylvania Railroad of 180 gross tons each. The Spedden Shipbuilding Company, also of Baltimore, built the lighthouse tender *Laurel* for the United States Lighthouse Department, the sea-going dredge *Minquas* for the United States Engineers' Department, and a tug for the Maryland Dredging Company in 1915, and now has under construction a new tugboat and is installing boilers in several other vessels.

A new shipyard on the Delaware River, the Chester Shipbuilding Company, Ltd., Chester, Pa., which has taken the site of the old Roach yard, is building two cylindrical tankers for carrying oil of about 5,800 gross tons each, fitted with geared turbine engines of the Westinghouse type designed to develop about 3,000 shaft horsepower.

The output of the Staten Island Shipbuilding Company, West Brighton, N. Y., in 1915, which consisted of six vessels aggregating 3,154 gross tons, included three tugs, a type of vessel in which this company specializes. There are now building at this plant four other tugs, as well as two steel lighters and a grain elevator.

The leading shipyard on the Maine coast, the Bath Iron Works, Bath, Me., specializes in government work and in 1915 delivered to the Navy Department the very successful destroyer *Wadsworth,* equipped with Parsons turbines and reduction gear and Normand watertube boilers. Three other destroyers are now under construction at this yard, as well as a swift turbine-driven yacht 225 feet long for Mr. D. N. Rouss. In addition to its government work the Bath Iron Works also built in 1915 the torpedo-testing steamer *Emblane* for the E. W. Bliss Company.

Although progress in the development of Marine Diesel engines in the United States has been somewhat slow, nevertheless the New London Ship & Engine Company, Groton, Conn., now has under construction 70 Nlesco Diesel engines aggregating 21,780 horsepower. In addition, the Brooklyn Navy Yard is building from designs of this company two 1,600-horsepower, six-cylinder, two-cycle, single-acting Diesel engines for the fuel ship *Maumee.*

Work on the Pacific Coast

By far the largest amount of shipbuilding on the Pacific coast is in the hands of the Union Iron Works, San Francisco, Cal. This company built two freighters of about 6,000 gross tons and 2,400 horsepower each, fitted with Curtis turbines, and also launched an oil tanker of 7,445 gross tons fitted with Curtis turbines of 2,600 horsepower in 1915. These, together with an oil barge of 387 gross tons for the Union Oil Company and a motor boat, comprised the output of the yard for the year. They now have under construction six large oil tankers, two being of 8,000 gross tons and four of 7,445 gross tons each. Two of these vessels are for J. W. Van Dyke, one for the Union Oil Company, and one each for the Standard Oil Company of California, the Standard Oil Company of New Jersey and the Standard Transportation Company of Delaware. Other work now in hand includes a twin screw turbine-driven passenger and freight steamer of 9,728 gross tons for the Matson Navigation Company and a freighter of 5,900 gross tons fitted with Curtis turbines for the Hind-Rolph Company.

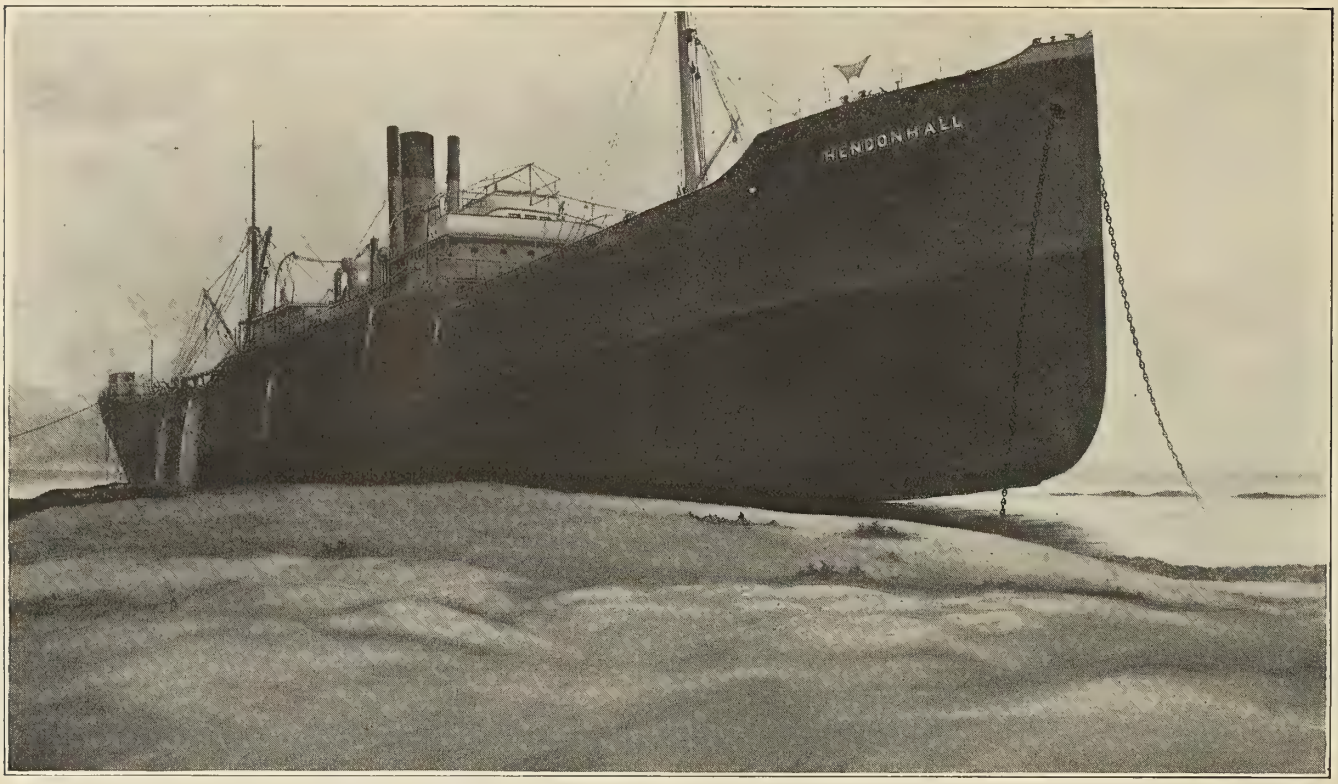
The Seattle Construction & Dry Dock Company, Seattle, Wash., completed the submarine tender *Bushnell* last year and now has under construction two freight steamers of 3,900 gross tons each for the New York & Cuba Mail Steamship Company and also three submarines and a destroyer for the United States Navy.

Hall Bros. Marine Railway & Shipbuilding Company, Winslow, Wash., built in 1915 the lighthouse tender *Fern* and the snagboat *Swinomish,* both of which have been described in recent issues of this magazine.

Shipbuilding on the Great Lakes

The American Shipbuilding Company, which operates four yards, has under construction at Lorain, Ohio, four bulk freighters of 7,000 gross tons each and one of 6,400 gross tons. Two of these vessels are for the Pittsburgh Steamship Company and one each for M. A. Hanna & Co., the Interlake Steamship Company and Herbert K. Oaks. At Cleveland the American Shipbuilding Company is building two bulk freighters of 2,100 gross tons, one for A. H. Skangaards and the other for Arthur Mathiesen. At Detroit, Mich., this company is building four bulk freighters of 2,100 gross tons each, two of them being for A. O. Lindvig, one for the George Hall Coal Company and one for Erling Lund. Another vessel of 2,100 gross tons is being built at Chicago for Erling Lund. The only vessel built by the American Shipbuilding Company in 1915 was the self-unloading bulk freighter, *W. F. White,* of 7,180 gross tons, for the Limestone Transportation Company.

The Great Lakes Engineering Works, Detroit, Mich., delivered ten vessels aggregating 9,603 gross tons in 1915 and now has under construction eleven vessels of 31,347 gross tons. The output in 1915 included three general cargo steamers of 1,414 gross tons each for the Clyde Steamship Company, two bulk freighters, a tug and several scows. The work now in hand includes a bulk freighter of 7,800 gross tons, a self-unloading freighter of 4,810 gross tons, three smaller bulk freighters, a wrecking steamer, two colliers and two cargo steamers of 2,500 gross tons each.



At Low Water the Bow of the *Hendonhall* Was High and Dry

The Refloating of the Hendonhall

Compressed Air Again Saves Another "Hopeless Wreck"— Vessel Kept Afloat Practically Without A Bottom

BY ROBERT G. SKERRETT

Modern methods, plus expertness and experience, have saved another "hopeless wreck"—this time the steamship *Hendonhall,* a ship of 4,000 tons gross, which went ashore while bound into the St. Lawrence from Cardiff, November, a year ago. For the better part of nine months the vessel lay on the rocks between Trinity Bay and Point des Monts. Storm after storm added to the gravity of her situation, as well as to the extent of her injuries. Her position was an exposed one and there seemed only the scantiest grounds for hoping for her release.

Various methods for her refloating were proposed, among them that of jacking her clear of the ragged ledge and then building launching ways under her. All of these schemes involved prohibitive outlays, considered in the light of the boat's current value. About the middle of July of the present year the Canadian Salvage Association, licensee of the Yankee Salvage Association, of New York City, took on the job of getting the ship free so she could be towed to Quebec. Mr. W. W. Wotherspoon, the well-known wrecking expert, was in charge of the operations, and on August 26 the *Hendonhall* was refloated.

Perhaps the most interesting feature of this salvage undertaking was that the damaged craft, in order to get her clear of the rocks, was floated at practically her "builders' light draft;" that is, the vessel was floated at the draft she would have had normally without coal aboard or water in either the boilers or double bottom. Manifestly, this meant giving the ship, and a badly damaged one at that, an exceptionally large measure of buoyancy, and this without recourse to extraneous means in the way of pontoons, etc.

The *Hendonhall* went ashore at high tide. At low water her bow was high and dry, although her stern still floated free. She was filled with water fore and aft, including the engine room. The bottom under No. 2 hold was crushed and opened so badly that the sea, during storms, broke inside of the vessel well nigh as freely as outside. The whole tank was ripped open, and the rent was even much larger than in the case of the *Royal George,* which the same company successfully floated two years ago. The task was made harder, inasmuch as it was decided to use compressed air, because the *Hendonhall* had no 'tween-decks, and special facilities were resorted to in order to strengthen the decks above and to deal with the very large cargo hatches on that deck.

The first thing done was to pump out the engine rooms, for otherwise nothing could be done. This work was successfully executed, and the tank tops were repaired there and in the other holds, except in No. 2. This latter compartment was 80 feet long, 48 feet in beam and 27 feet deep. The crux of the operation was to get the water out of this hold. Before this was done the vessel was lightened by removing 500 tons of bunker coal. After the deck was braced compressed air was pumped into the hold at a pressure of six pounds to the square inch. Oil-driven air compressors were used for that purpose and for the first time in Canada. The independent nature of this type of compressor makes it ideal for such service. It may be

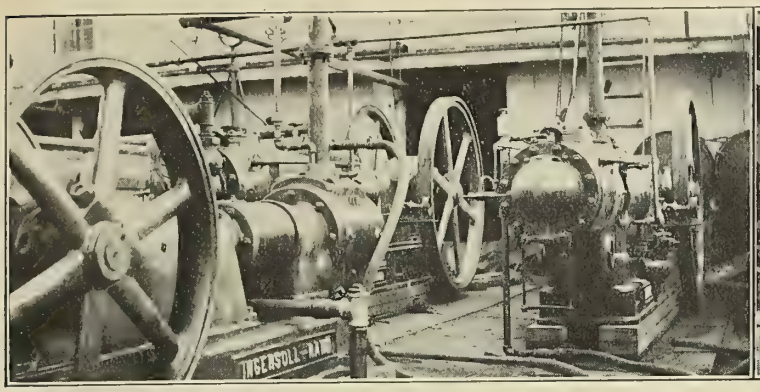


Fig. 2.—Air Compressors Mounted on Deck



Fig. 3.—Patches on Injured Tank Top

easily mounted directly upon a wreck if there is a small area of level surface available, and it may be run continuously, irrespective of steam or any other power; it burns practically any of the cheap fuel oils, as kerosene (paraffin), distillate, naphtha or crude oil. One of these

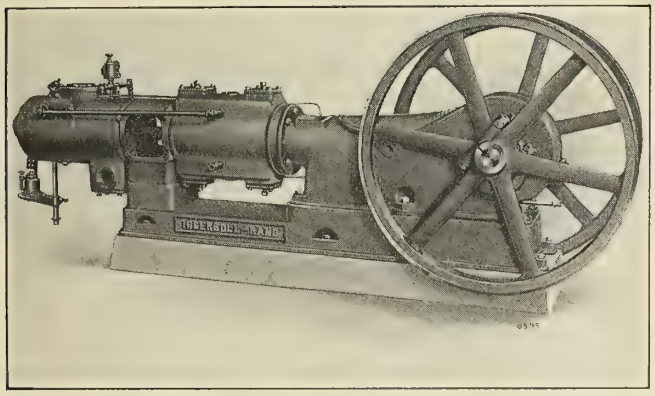


Fig. 4.—Ingersoll-Rand Oil-Driven Air Compressor

oil-driven machines was run continuously 24 hours a day, 300 revolutions per minute, without stop or breakdown, for three weeks and one day, starting at 9 A. M. on August 22. The severity of such a test was accentuated by the fact that, although designed for delivering air pressures from 70 to 100 pounds, this compressor was operated at a totally different air-discharge pressure, namely, 4 pounds per square inch.

The oil-engine compressors are known as "Ingersoll-Rogler" Class 'ERO.'" The engine and compressor are mounted on a common base and connected directly on the "straight-line" principle, having a common stroke of 10 inches. The compressor cylinder is double acting, 10 inches in diameter. The oil-engine cylinder is 12½ inches in diameter and operates on the "two-cycle" principle. The rated piston displacement of the air cylinder is 261 cubic feet per minute, and the fuel consumption operating at 100 pounds air-pressure averages 3½ gallons per hour, based on fuel having a thermal value of 20,000 British thermal units per pound. At the low-pressure at which these compressors were run, the fuel consumption was considerably less than this figure.

The ticklish part of the undertaking lay in nicely adjusting the vessel's draft, because she was so caught under hold No. 2 that only a few inches of leeway was allowed in regulating her trim. It was necessary that she should not draw more than 6 feet 9 inches forward and 14 feet aft, lest any acuter angle increase the grip of the rocks even at high tide. Thanks to the skillful manner in which she was handled, the *Hendonhall* was freed about an hour and a half before high water on a moderate spring tide. At the time of her release her engine room was purposely partly flooded and a quantity of water was carried in No. 4 hold, not only to assist her trim by the stern, but to list her in order to facilitate her clearance.

The ship was kept afloat practically without a bottom, and was taken up the St. Lawrence River to Quebec, a distance of about 250 miles.



Fig. 5.—Bow View



Fig. 6.—Position of the Steamer on the Rocks at High Water





Although the Construction of Sailing Vessels has Steadily Declined in Recent Years, Nevertheless the Above Photographs Taken Recently Outside of Sandy Hook Show That Employment is being Found At the Present Time for the Existing Fleet of "Windjammers"

Modern Submarines in War and Peace—VII

Under-Ice Navigation with a Submarine—Experiments and Tests with the Protector in 1903

BY SIMON LAKE

All navigators know the difficulty of attempting to break their way through ice fields, since it requires a vessel of tremendous power and great weight to break down, or through, solid ice. Fig. 51 illustrates a vessel designed by the author in 1903 for navigation in ice-covered waters. A vessel of this type was first proposed by the author in 1899 for exploration purposes in ice-covered seas. In 1903, experiments were made with the *Protector* in order to demonstrate the practibility of navigating in ice-covered waters.

Professor Nansen, in his North Polar explorations, has stated in his book that his average rate of progress during eighteen months, in attempting to reach the North Pole, was only three-quarters of a mile per day, and that the thickest ice he found during these months of endeavor was 14 feet. His progress was delayed by open waters, slush ice, and in the winter by the intense cold, which compelled him to "hibernate" for a considerable period of time.

An under-ice submarine as illustrated, with large storage battery capacity, could navigate underneath the ice in perfect comfort and safety. The temperature surrounding the vessel, even in the most severe winter weather, would not exceed the temperature of the sea water. The vessel above illustrated is designed to make a continuous submerged voyage of 150 miles on one charge of the storage battery. After such a run, it would be necessary to stop and recharge the batteries. If open water should be encountered, this recharging process would be done by bringing the vessel to the surface. If the ice was not too thick, then by blowing out the water ballast the ice would be broken, since it is very much easier to life the ice and break it, rather than to force it apart or downward, as surface vessels are compelled to do.

Provision is made for boring a hole up through the ice so as to permit the drawing in of sufficient air to run the engines and to recharge the batteries. Provision has also been made for putting out small mines underneath the ice to blow an opening to permit the submarine to come to the surface. A telescopic conning tower arranged to cut its way up through ice 12 or 14 feet thick is also provided to enable the boat to remain under the ice and still permit the crew to reach the surface.

In navigating in an ice-pack, the method of procedure would be to reduce the buoyancy of the vessel to, perhaps, a couple of tons, and then steam ahead, and it will be observed that the forward portion of the boat extends downward a considerable distance under the water, so that when the forward portion of the boat contacts with heavy ice the reserve buoyancy will not be sufficient to lift or push the ice out of the way, and the vessel will then be automatically pushed under the ice and run along in contact with the under surface of the ice. A toothed recording wheel would give the exact distance traveled, and of course the compass will give the direction. Progress could be made in perfect comfort and safety under the ice at a rate exceeding 100 miles per day.

Fig. 51 shows the vessel fitted with torpedo tubes, and an athwartship propeller in the stern for training the vessel, and also with bottom wheels to permit navigation on the water bed. This combination would permit vessels of this type to enter ice-bound ports or harbors and destroy the enemies' shipping while the same lies "frozen in" and helpless.

The *Protector*, which was fitted out in 1903 for experi-

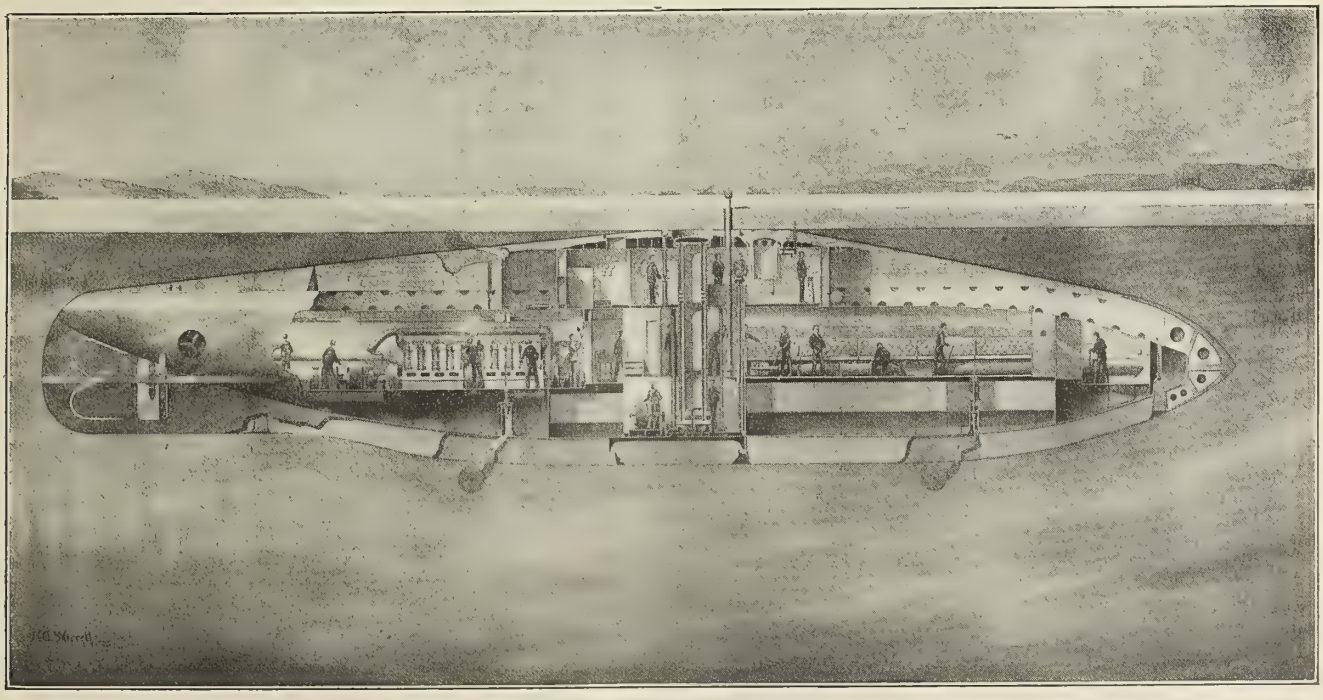


Fig. 51.—Under-Ice Navigation

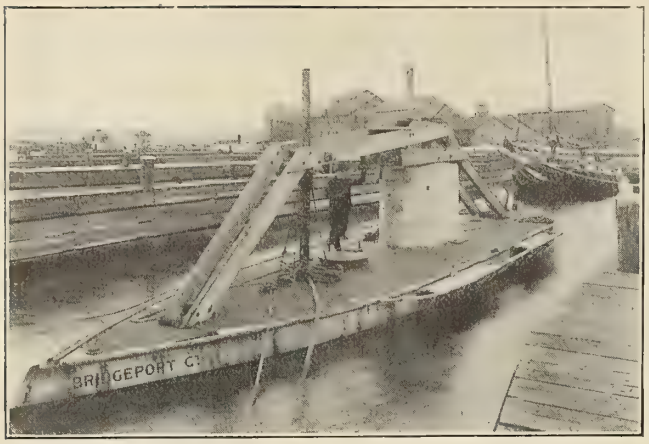


Fig. 52.—The *Protector* Fitted in 1903 for Experimental Navigation Under the Ice

mental navigation under the ice, is shown in Fig. 52 with an inverted toboggan built up over the conning tower. This arrangement enabled her to readily navigate under ice fields. The view of the *Protector* shown in Fig. 54 was taken before she was fitted with the experimental inverted toboggan, and shows the vessel emerging through an ice field in Narragansett Bay. This ice field was about 8 inches thick, and she readily broke her way up through same. The United States Army Board, General Arthur Murray, and Captains Bailey and Parker are shown on top of the conning tower.

Ice two feet in thickness is sufficient to close navigation to the most powerful of ordinary surface ships, and great power is required to crush or break a lane through it by the specially equipped ice breakers now used in northern latitudes.

While ice is a deterrent to surface navigation, it is actually an aid to under water navigation, providing the submarine boat is specially equipped with guide wheels or "runners" on top of the hull to enable her to "slide" or "wheel" along under the ice.

The principal feature of the design of under-ice submarine illustrated was prepared by the author a number of years ago to meet the desires of an associate of Captain Nansen, the Arctic explorer, for a vessel that could be navigated either on the surface or under the ice. I

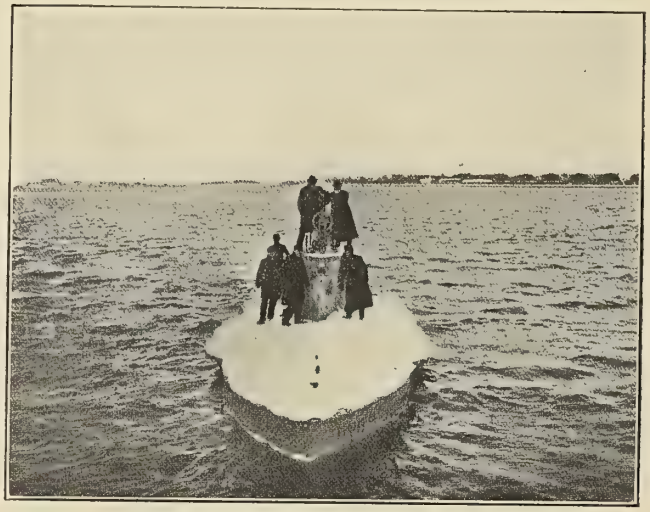


Fig. 54.—The *Protector* Returning to Fort Adams with Army Board on January 20, 1904. Deck Covered with Ice

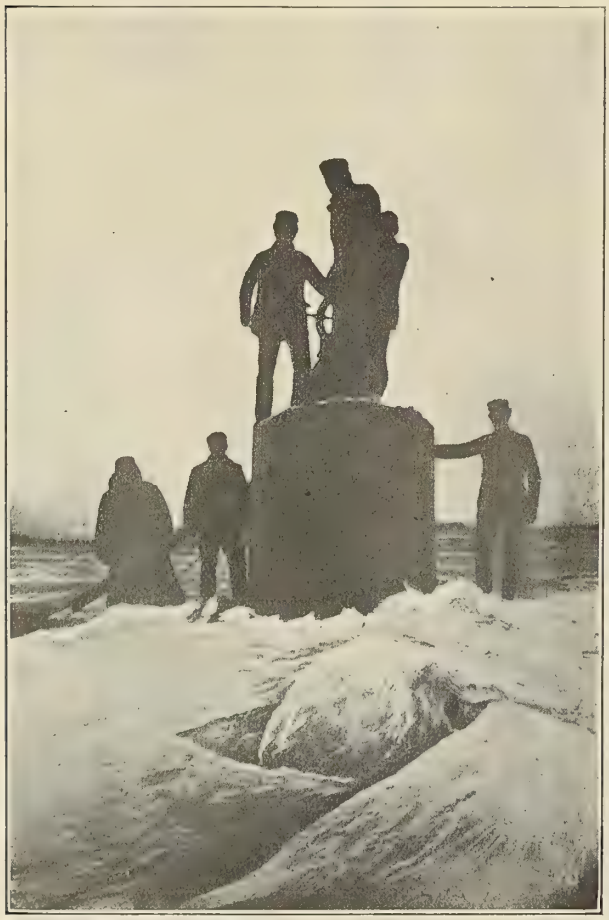


Fig. 53.—The *Protector*, After a 3-Hour Submerged Run, Emerging Through a Heavy Ice Floe. Members of an Army Board on Top of the Conning Tower

explained the principal features and possibilities of a vessel of this type for under-ice navigation before the faculty of Johns Hopkins University, in Baltimore in 1898, and at one time I thought one of the prominent New York daily newspapers was going to finance the building of such a vessel for North Polar exploration work, but the submarine was then looked upon as too much of an experiment and nothing ever came of the negotiations.

Some years afterward, in Christiania, Norway, I met and discussed the project with Captain Scott Hanson, R. N., who was associated with Nansen in his historical search for the North Pole, and he became quite enthusiastic over the possibilities of a submarine of this type for North Polar exploration.

An under-ice submarine of the type illustrated, fitted with large storage battery capacity, would be able to average one hundred miles per day under the ice, and about two hundred and fifty miles per day in open water. Starting from Spitzbergen, therefore, and going over Nansen's route, if the same conditions were met as he describes, the round trip to the Pole should be made in about ten days' time, and in perfect comfort, as no matter how cold the weather is above the surface, the temperature of the water surrounding the submarine is always above the freezing point.

Later I was asked to submit to the chief engineer of one of the Canadian railways plans for an under-ice cargo-carrying submarine to enable them to transport passengers, mail and freight from their main land terminal at Vancouver to an open harbor on the island of Victoria.

(To be continued.)

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

A Marine Engineer's Kit of Tools

My boy graduated from a technical school the early part of last summer. Since then he has been working in an office where he could wear nice clean cuffs and a stiff collar, but he came home a couple of weeks ago and told me he had "tendered his resignation" (we used to call it "quitting the job"), and that he was going to sea as an oiler on one of the M. & N. boats.

I am a machinist by trade, and therefore know what a good kit of tools means, so to start my boy right I shall fit him out with the following articles:

Center punch.
4 and 6-inch in- and outside calipers.
4 and 6-inch hermaphrodite calipers.
4 and 6-inch dividers.
6-inch hardened try square with beam.
6-inch hardened try square flat.
Thread gage.
2, 4 and 6-inch steel scales, divided in tenths and eighths.
Center gage for lathe work.
20 feet of No. 20 piano wire, with anchor and turnbuckle.
20-foot chalk line and piece of chalk.
Soapstone pencil.
Plumb-bob and level.
Small hand drill with chuck.
A dozen small twist drills, ⅛ and smaller.
Lot of short pieces of drill rods to match drills.
1-inch micrometer.
9-inch scriber.
Depth gage.
Bottle of copper solution.
Bottle of collodion.
Adhesive tape, court plaster, small pair of scissors, safety pins, needles, threads and buttons.
Sheet of crocus and emory cloth.
Small oil stones.
Small oil can.
Mirror, 2 by 4 inches.

A friend, who is also a machinist, dropped in to see me, and I showed him the list and asked him what he thought of it. He read it over and said: "I have never been to sea, but I should think that if you give the boy a center punch, a hammer would come in handy."

There, Mr. Editor, I had overlooked one of the most important things in the whole kit. So I am going to ask your readers to look over this list, if you think it is worth while publishing it, and say through your columns whether I have got too much or too little in the way of an outfit for the boy.

I have my doubts about a level or a plumb-bob being of any use at sea, but naval engineers ought to know.

I have always found a small mirror very handy to throw light into dark corners, also for looking at the under side of something where you couldn't stick your head. The tool chest in which I am going to put all these things will have a flat top and it will be made of nice, well-seasoned white pine, so that it can be used as a drawing board. And, of course, it will be nicely squared up, and I will put some thumb tacks, a small T square and a forty-five and sixty-degree triangle in the kit.

The anchor and turnbuckle, or stretcher, has to be home-made, as I do not find them in the market. The anchor is a piece of round drill rod, ½ inch diameter and ½ inch long, drilled for the wire and provided with a set screw to hold it. The turnbuckle can be made to suit anybody's fancy.

For the copper solution to overcome the trouble with greasy surfaces the following recipe will be found very satisfactory. To a half ounce of blue vitrol dissolve in four ounces of water, add slowly, drop by drop, a teaspoonful of sulphuric acid.

THE BOY'S FATHER.

Repairs to a Defective Tube

Cleaning a boiler isn't a very pleasant task, but it's a very gratifying piece of work, for it gives one a lot of satisfaction to know the actual conditions both inside and out. The engineer who neglects cleaning the boilers sooner or later suffers from the neglect, and the following incident is one of the few examples of this.

I might say that this particular engineer was in the habit of cleaning the boiler every week when possible, but, due to work out of our regular schedule, we didn't get an opportunity to clean until it was too late.

This boiler was a Mosher watertube boiler and very satisfactory in every way. But the rest of the installation was very inefficient. A steam jet was used for forced draft, and, of course, necessitated considerable make-up feed water to be supplied. Water coolers were used on the bearings constantly, the water draining into the bilge and put overboard by a steam injector, another large user of steam and make-up feed water. Boiler injectors were used quite frequently, besides a deck winch exhausting into the atmosphere. Roughly, I would say that about 30 percent of the feed water had to be taken direct from the sea cock. It is this fact and the circumstance that we were running in and out of muddy rivers that made it so necessary to clean often.

As before stated, we didn't get an opportunity to clean on this occasion, and, with the other boiler in a bad condition, we left Milwaukee for Detroit. When north of the Manitou Islands the fireman noticed one of the tubes near the front getting rather light in color. The engineer was called, and it was evident to him that the tube was getting no circulation. The fireman was ordered to put ashes on the fire under the tube and thus relieve the heat in it. But this did no good, for in a few minutes it burnt and blew through, although not badly, because of the baked mud and scale in the tube. As we did not lose water very fast, we steamed ahead slowly as far as St. Ignace, where we pulled fires and blew the boiler down and cleaned thoroughly.

The Mosher Company used to furnish plugs to use in such a case, but we had neither plugs nor spare tubes, so it was necessary to make plugs for the occasion. These plugs were fitted and the boiler fired. The plugs, such as they were, didn't fit very well and the leak was still too great to proceed further.

The engineer had a tube expander among his personal possessions, and he went about fixing it in the following manner:

About 10 inches of the tube at each end was still in good condition, so we cut out the tube, cut off the good ends into two neat lengths of about 8 inches each. We then headed an end of each tube and hammered it closed and welded. These were then inserted in the manifolds and rolled from the furnace side, forming what the engineer called a "dummy."

Steam pressure being on the outside of the "dummies" tended to keep the blind end closed, and when pressure was again raised no leak was perceptible. I believe these "dummies" have never since been replaced by a new tube.

N.

The Preservation of Marine Boilers

To the seagoing engineer the condition of the boilers under his charge is a constant source of anxiety, and justly so, for on them all other parts are directly dependent. As a consequence there is no work in the engineers' department which will count to greater advantage than constant and intelligent care in fighting the forces of deterioration, either mechanical or chemical, or both, which commences immediately after the boiler is lowered into the hold of the vessel.

Of the two forms of corrosion, internal and external, the latter is the one the great percentage of boilers suffer from the most, and, in fact, if they could be kept perfectly tight, so that there was no leakage at rivets, seams or tubes, internal corrosion, except in rare instances, would cause but little trouble and the life of the boiler would be doubled and trebled. However, as the perfect boiler is yet to be built, the best that can be done is to check all leaks as soon and as effectively as possible.

Unfortunately, the exigencies of marine service in many cases are such that the boilers are kept under steam for many days continuously, thereby preventing repairs which should be made at once, and as a result when the opportunnty does come the fault has become greatly aggravated, requiring much greater skill and labor to make it good, if, indeed, it can be successfully repaired at all.

In placing boilers in the ship, care should be taken that the saddles do not come in line with the circumferential seams, as these latter at the bottom of the shell are very liable to leak. A longitudinal seam at the bottom of the shell is very liable to be a constant source of trouble.

The most common sources of external corrosion are exposure to leakage from joints, tubes or fittings, dripping from mountings, moisture rising from the bilge and sweating. Serious sources of corrosion of the heating surfaces result from neglect to thoroughly clean furnaces, tubes and connections of ashes and soot before they have had an opportunity to absorb moisture, which they will do shortly after they become cold. Ashes collecting in cracks and joints between bridge walls and furnaces after fires are hauled soon absorb moisture and rapid corrosion of furnace plates is the result. Wet ashes by the front of the boiler are especially destructive. In cleaning furnaces a half a dozen bars taken from each will allow the ashes to be thoroughly removed from the bearers and bridge walls.

Leaky seams and rivets should be calked at the earliest opportunity; in some cases in old boilers where the seam is beyond calking and is on or near the shell bottom the application of a dose of cement will often greatly check or stop it. Take about equal parts of Portland cement and fresh, sharp sand, mixing with fresh water to the consistency of mortar and apply to the faulty seam from the inside of the boiler. Wherever the cement is to be applied the metal should first be thoroughly cleaned with lye to remove any grease or sediment.

If leaky tubes are not attended to at once a thin layer of rust will form between the tube and sheet, rendering it a difficult matter to make the tube tight ever after. If the tubes become thin and weak from rapid expanding the only remedy left is, after a final expanding, to fit ferrules, driving them in solidly. The writer's experience with cast iron ferrules has not been altogether satisfactory. Some of the tubes in a Scotch boiler in the ship on which he last served were fitted with cast iron ferrules, but the tubes remained tight only a short time and it finally became necessary to remove these ferrules and substitute others of wrought iron, after which no further leaking occurred.

The one effective method of checking leakage around screw stays with riveted heads is by upsetting; that is, with a heavy sledge held firmly against one head, several sharp blows with a quarter hammer on the leading head will fill out its threads into those of the sheet, making it perfectly tight. Calking the heads is a little worse than useless. Internal calking is an evil, from the fact that it is often the cause of serious grooving of the plates. It is never necessary in a well-made boiler.

Considering the question of corrosion chemically, we find that dry, pure oxygen alone has no action on iron or steel; moist oxygen acts only very slowly, and pure, dry carbonic acid has no action. But when these gases are mixed in the presence of moisture, as in the hold of a vessel, rust or corrosion rapidly follows and goes on at an increasing rate. To abate this evil all possible means should be taken to drive out of the boiler compartments as much of the moisture as possible. When the weather is dry much benefit may be derived from running one of the blowers moderately in each compartment if the boilers are not to be used for some time; an auxiliary steam pipe might be tapped, and a line of pipe led into the lower manhole of each boiler, the boiler otherwise being closed so as to retain the heat, the pipe thence leading to the trap. This method the author used on the boiler of one of our coastwise steamers with excellent results. The interior of the boiler remained dry and there was no external sweating, excepting from a foot or two from the back head beyond the heater pipe. With this method care should be taken that there is sufficient pipe to not only raise the temperature of the air inside the boiler, but also to raise that of the shell slightly above the surrounding external air, otherwise sweating of the shell will go on inside as well as outside.

An excellent method of checking internal corrosion is the introduction of a barrel or two of quicklime into the empty boiler and then closing all plates, the lime absorbing the moisture and effectually checking the corrosion.

Of the different forms of internal corrosion, pitting or honeycombing is the most serious, and it first made its worst attacks in marine boilers at the time of the introduction of the surface condenser. Of this form of corrosion it has been truly said that the only characteristic that was uniform in relation to it was the want of uniformity with which it occurred. It is certainly most capricious in its attacks, be it in the same boiler or in a battery working under exactly similar circumstances. It may be found on every plate or on only one plate of a boiler, generally below the water level, although at times above it. The braces are sometimes the only part affected, while again these latter are free and the plates are seriously attacked. In a half dozen boilers made of the same brand of plates, in the same shop and then worked side by side, one boiler will be seriously affected by pitting, the remainder suffer-

ing very little, if at all. Unlike ordinary corrosion, pitting is marked by sharply defined edges, resulting in holes and patches of from one-quarter inch to six inches or more in diameter, and often assuming very irregular shapes, the depth of the pitting varying from one-thirty-second to one-quarter inch or more.

Sometimes this form of corrosion acts in a somewhat different manner, the plates becoming indented by very small holes close together, somewhat resembling in appearance the wood sheathing of a ship which has suffered from the effects of teredo. Perhaps the most satisfactory method of dealing with this form of corrosion, termed honeycombing, is the application of cement. Where it is applied to heating surfaces the following method has been used with very satisfactory results: First, thoroughly clean the surface affected, mix Portland cement with fresh water, without sand, to about the consistency of ordinary whitewash, and apply two coats with a whitewash brush. It will seldom be necessary to repeat the dose unless the boiler has been subjected to sudden changes of temperature, when it will be well to examine it carefully to see that the cement is not cracked. There have been many theories advanced as to the cause of this pitting action, among the more plausible of which are:

Galvanic action, caused by particles of copper or brass from the condenser tubes, air pumps and feed pipes carried in with the feed water, which latter being acidulated, the more likely alkaline becomes the exciting agent. However, inasmuch as these particles of copper or brass would by their weight gravitate to the bottom of the boiler, or lodge on the tops of tubes or furnaces, here is where we should expect to find the greatest corrosion or pitting, which, unfortunately for this theory, is not by any means the case. There is undoubtedly a very material wearing away of copper and brass pipes, due to the mechanical action of water and steam, aided possibly by any oily acid which may be present.

Hydrochloric acid, produced within the boiler by the decomposition of the water, its hydrogen combining with the chlorides contained in the sea water, is by some regarded as the cause. If such were the case the water would become strongly acidulated, and if it obtained sufficient strength to produce pitting it would have a decided solvent action on zinc placed therein; moreover, numerous analyses made of water from boilers in which this pitting action has gone on seriously have always shown it to give an alkaline reaction.

Decomposition of cylinder lubricants is pointed out as another cause. The resulting fatty acids dissolve the brass of the condenser tubes and pass into the boiler and convert water into a solution of copper, which acts electrochemically on the water and iron, thereby causing corrosion or pitting. This action, however, would cause a wear on the condenser tubes proportional to that of the boiler iron; moreover, pitting is found to occur just as much when the condenser tubes are tinned. Again, as stated above, the water from marine boilers, except in very rare cases, is found to be distinctly alkaline; also analyses of the water show not the slightest trace of copper in solution.

Presence of free oxygen is the basis of still another theory, it being thought that the presence of free oxygen in the boiler derived from the feed water would rapidly attack the iron. This theory may be partially true, in so far as affects uniform corrosion, but that free oxygen could be, by itself, the cause of pitting seems extremely improbable. On joining the last ship on which the author served he found that the vapor escape pipe from the filter had been closed. The filter was a cast iron box with closed top, having a connection with the air-pump discharge, and also fitted with connections to a weighted outboard valve. The feed pumps, being above the filter, we kept the latter closed in order to create a pressure to force the water to the feed pumps. As a consequence, much air was forced into the boiler along with the feed water, and much oil also kept it company. Now, although this boiler had been fed with oil and air in allopathic doses, a very careful personal inspection from above and below showed not the slightest trace of pitting or of undue corrosion.

The real cause of pitting in boilers, although now largely checked, has never been satisfactorily explained. Undoubtedly this peculiar destructive form of corrosion is due to no single cause, but rather to a combination of causes, which has yet to be discovered. It has been checked much the same as a doctor might check a disease of which he was unable to make a diagnosis by administering all the different combinations of medicines he could think of as bearing on the case.

The following are some of the precautions used to prevent pitting: Carefully pickling the boiler plates to remove all mill scale or oxide. Fitting large quantities of zinc in the boiler. Preventing the entrance of atmospheric air. Using only the highest grades of mineral oils in the cylinders, and little of that. Filtering the feed water to prevent the entrance of oil or other foreign substances. Tinning the condenser tubes. Using only pure water. Changing the water in the boiler occasionally. Use of sodic carbonate and sometimes of other salts.

With these combinations, in whole or in part, pitting has been largely, if not wholly, checked.

Although the weight of opinion in regard to fitting boiler zincs is in favor of close metallic contact, yet experiments which have been tried go to show that zinc simply suspended in the water of the boiler gives equally efficient results. The analyses of many samples of boiler water have shown zinc in solution, and it is a question whether the prevention of corrosion is not principally due to zinc in solution rendering the water non-exciting.

The quantity and the disposition of the zincs fitted in a boiler depends somewhat upon various conditions, such as the age of the boiler, the way it shows in tendency to undue corrosion, the kind and amount of service and the kind of water used. Rolled zinc, being purer, should always be used when possible, in preference to cast zinc. The length of time zincs will remain effective depends upon the amount of steaming and the condition of the boiler. A careful record of zinc consumption in boilers supplying engines of 1,000 indicated horsepower showed 10 pounds to 12 pounds of rolled zinc per 24 steaming hours when boilers were new. Afterwards, when in good condition, free from undue corrosion, about 5 pounds per 24 hours of steaming.

Zincs, to be effective, should not be placed over six feet apart, it having been ascertained by a series of experiments that they exerted their influence in checking pitting over only a radius of 3 feet. Zincs are of little or no use in the steam space, except when the boiler is out of use and kept full of water as a means of preservation, and in which case this portion of the boiler should contain from one-fifth to one-sixth the whole number.

Zincs deteriorate either gradually by the wasting away or by a gradual change of substance, the latter being the much more common process. They become of a dark gray or black color, brittle and more or less friable, presenting a warped, cracked or honeycombed appearance, with apparently little of a metallic nature left in their composition. Even if placed in a crucible and heated to redness, this resulting substance does not melt.

In raising steam in the ordinary Scotch boiler, plenty of time should be taken, in order to prevent severe strains

resulting from expansion. Where no means are taken to start the circulation of the large amount of water over the furnaces it is no uncommon occurrence, even though four or five hours are consumed, to have steam on the boiler while the bottom of the shell is still cold. In such a case the difference in length of the top and the bottom of the shell would amount to approximately a quarter of an inch in an 18-foot boiler, producing severe strains, and as a natural consequence continual leakage along the bottom shell seams.

As an illustration of the evil results of sudden changes in boiler temperatures, the following fact is quite to the point: It was in the winter season and the vessel was at anchor off the Massachusetts coast. One night about 2 A. M. a flange gasket near the bottom of the boiler blew out. Fires were immediately hauled and the boiler blown down, a new gasket fitted, water run up, fires lighted and the ship ready to get under way at daylight. A day or so later the vessel arrived in New York. The boiler maker's bill for calking leaky joints was about $75 (15/12/6), and the mischief did not end here, as the tubes and seams soon leaked badly again, and were only checked after additional expense for fitting ferrules to tubes and cementing seams. It is perhaps superfluous to add that this event took place in the interim between the vacation of the ship by the chief engineer and the arrival of the new chief.

In vessels where there is no auxiliary boiler and the boiler water level is below the sea level, it is a good plan to pump up to, say, a little over one-half a glass, two or three times before steam forms, to open the bottom blow and allow the water to fall an inch or two, thereby bringing the warmer water down to the bottom of the shell. Before the introduction of the hydrokineter it was a common practice to run a steam pipe into the bottom shell of the boiler to start in live steam from the auxiliary boiler shortly before lighting fires.

Another and excellent method of effecting circulation is by means of an auxiliary feed pump, having a branch suction to the bottom blow pipe, by which means the water is drawn from the bottom of the boiler and forced in near the water level.

Boilers should always be fitted with internal feed pipes, preferably leading upwards toward the water level, thus not only giving the boiler better circulation, but preventing the emptying of the boiler in case of accident to the feed valve. This also prevents corrosion of the boiler shell, which often occurs where no internal pipe is fitted, or if fitted is so led as to project the feed water against the shell plate.

Dampers should be fitted in each uptake so that when cleaning or banking fires the draft can be checked, avoiding the strong rush of air on the highly heated crowns and tube sheets. The author can speak from solid experience in this matter and can vouch for the usefulness of this appendage in avoiding leaks in furnaces, back connections and tube sheets.

An injector in each fire room is very useful, preventing the necessity of ever forcing cold water into boilers. It should be provided with a swing check in delivery pipe, close to its entrance to auxiliary feed pipe, or check valve, as the case may be. It is preferable for the injector to discharge into the auxiliary feed, for the reason that if it is desired to work the feed pump and injector at the same time, the pulsations in the feed pipe from the pump are apt to break the flow from the injector. If the latter is placed low in the ship it will sometimes refuse to work, especially with low steam, from its becoming flooded from the head of water. This can readily be obviated, however, by adjusting or partially closing the supply valve fitted in the suction pipe.

Before getting under way, it is a good plan to draw out any water which may have collected in the condenser, for, even if it has not acted slightly on the brass or copper, it sometimes contains more or less oil.

As soon as the boilers are empty they should be scaled if necessary, thoroughly washed out with a steam hose, and then carefully drained. Care should be taken to remove any loose scale, as it forms excellent little pockets or reservoirs for holding moisture. This frequently happens around the tubes or braces. Heating surfaces of boilers using forced draft should receive extra care and attention as to their cleanliness.

It should be remembered that boilers aboard ships in commission deteriorate more rapidly when out of use than when under steam, and consequently this is the time they should receive the engineer's greatest attention. All steam or water connections should be kept carefully closed on the boilers out of use to prevent the entrance of moisture from such sources. Water condensed in the escape pipe will sometimes find its way to the safety-valve seat, and when the valve is lifted, as it should be occasionally, it passes into the boiler. To prevent this, drain pipes should be fitted close to the valve below its seat.

After the furnaces, connections, ash pits and uptakes have been cleaned and any necessary repairs have been made, the boiler should be closed, leaving off only the lower manhole. Fires should be lighted in portable sheet iron furnaces or trays and placed in the ashpit of each furnace, the uptake damper being partially hauled so as to retain the heat. These fires should be lighted frequently, say three times a week, as long as the boiler is out of use. Each time after finishing with these trays place them, with the smouldering coal, in the lower manhole and loosely secure the plate in position until they are needed again. The coke will absorb much oxygen and so tend to check internal corrosion.

Another method is to pump the boiler quite full of salt water, adding about 50 pounds of sodic carbonate per 100 cubic feet of space in the boiler, the right amount of carbonate being readily determined by placing a bright piece of iron in a sample of the boiler water. If the iron rusts after several hours of immersion, add more carbonate. Before closing the boiler the zincs should be in good condition and additional ones fitted above the water line. Light fires should then be started to heat the water sufficiently to drive off entrained air. This latter method cannot well be applied to boilers of ships in commission on account of the many disadvantages. Another method which has sometimes been adopted in boilers out of commission, and with very good results, is that of giving them inside and outside two or three coats of boiled linseed oil.

As stated above, all exposed portions of the boiler should receive a good coat of paint before they become thoroughly cold, or, at any rate, before they begin to show any signs of sweating; otherwise as soon as steam is raised the paint will blister, crack and peel off.

Never use whitewash on any portion of the boiler, as it greatly promotes corrosion unless it is put on over a very heavy coat of paint. At best, it presents a slovenly appearance and requires constant renewal. Moreover, as the painting should be renewed occasionally, it becomes necessary to thoroughly clean off the whitewash—a tedious, dirty job.

Boilers of ships spending much time in the tropics are comparatively short-lived, due to excessive corrosion from the warm, moist air, and when so stationed extreme exertions should be made to protect them as much as possible.

Finally, at all times work the boilers as *regularly, evenly* and as *easily* as the service permits.

Brooklyn, N. Y. Thomas J. Rogers.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Self-Trimming Vessels

Q.—Will you kindly describe the arrangement of a self-trimmer and give some sketches? N. A.

A.—By a "self-trimmer" is commonly meant a vessel which is so arranged structurally that when carrying loose bulk cargoes the cargo will flow into the holds with little, if any, trimming by hand being required to ensure the cargo completely filling the holds. The commonest forms are those which are so built that they have a central trunk or feeder which, when filled, ensures that the cargo, by nature of its fluidity, will eventually reach all parts of the holds. Cargoes such as grain or coal are those most commonly handled in this way, and vessels of the turret, trunk or cantilever framed type are illustrative. Frequently ore-carrying vessels have also longitudinal wing bulkheads extending throughout the lower part of the hold, which make an angle with the tank top sufficient to trim the ore in toward the center line so the unloading grabs can clean out the hold.

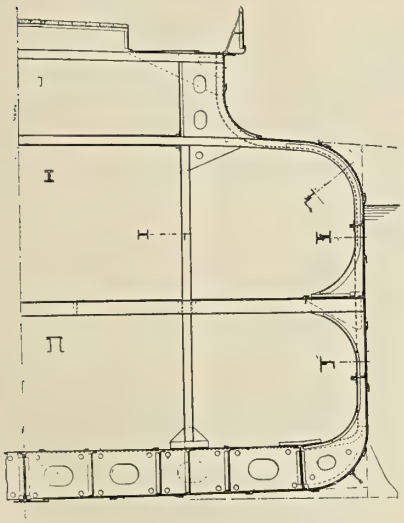


Fig. 1.—Turret Deck

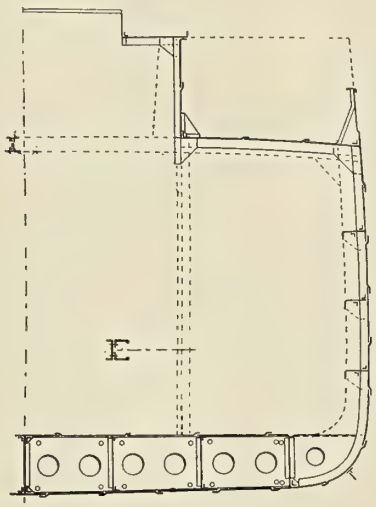


Fig. 2.—Trunk Deck

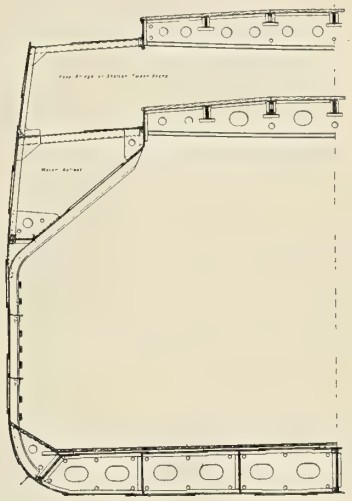


Fig. 3.—Cantilever Framed Type

Effect of Soot on Boiler Tubes

Q.—How much will soot in the tubes of a Scotch boiler reduce its efficiency? B. M.

A.—Soot is a very effective insulator and its effect in decreasing the efficiency of heat transferring apparatus is surprisingly large. It has been stated as the result of experimental investigation that a coat of soot 1/16 inch thick reduced the heat-transferring ability of tubes to 75 percent of that of the clean condition. Gains in efficiency due to cleaning tubes have frequently been reported of 10 percent.

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

Calorific Values of Fuel Gases

Q.—I frequently see in articles which give the results of analyses of fuel gases for gas engines two calorific values quoted, one termed "higher" and the other "lower." Will you please tell me the reason for two values and why there is such a discrepancy; is it due to unavoidable errors in the determination or to some other reason? E. G.

A.—When a fuel gas which contains hydrogen burns, one of the products of combustion is water (H_2O). If the temperature of the burnt gases is below the boiling point of water, the water of combustion remains in the liquid state and the B. T. U.'s found by analysis for this condition is the so-called "higher" calorific value. If, however, the temperature of the burnt gases is higher than the boiling point of water the water of combustion is maintained as steam and requires a certain number of B. T. U.'s to keep it so, or rather renders a certain number unavailable for discharge. The calorific value in this second case is the so-called "lower" value, and differs from the "higher" value by an amount equal to the latent heat of the water of combustion.

In gas-engine work in England, Germany and here, the lower value is usually used in computing efficiencies, but in France the higher value is used; the latter would seem to be the fairer comparison, as the temperatures are always such as to have the water in the form of steam in the exhaust.

Boiler Horsepower and Engine Horsepower

Q.—Please distinguish for me the difference between a boiler-horsepower and an engine-horsepower. Why don't we provide boilers of the same horsepower as the engine has indicated horsepower? J. B.

A.—A boiler horsepower is an arbitrary heat transfer value of 33,455 B. T. U. per hour. An engine horsepower is 33,000 foot pounds of work per minute. The former

was accepted as standard many years ago (1885 and 1898), and on its original acceptance corresponded to the heat necessary to convert 30 pounds of water into dry steam at 84.7 pounds absolute from feed water of 100 degrees F. The steam per horsepower per hour for engines working at about that range was not far from the 30 pounds then accepted, so that then the two (boiler and engine horsepower) were approximately the same. Now there is no definite relationship between the two, as the steam consumption of engines varies from 10 to 60 pounds per hour, depending upon many conditions.

In general, however, a modern engine of any of the common types and ranges of pressure should have an economy of from 200 to 400 B. T. U. per indicated horsepower per minute, or 12,000 to 24,000 per indicated horsepower hour. This would correspond to 33,455 ÷ 12,000 = 2.8 indicated horsepower, which would be handled by one boiler horsepower at the upper limit, and 33,455 ÷ 24,000 = 1.4 indicated horsepower at the lower limit. In designing large plants it is generally considered sufficient to provide boiler horsepower equal to half the indicated horsepower.

Coefficients of Friction of Lubricating Oils

Q.—What should be the coefficient of friction for good lubricating oils used for marine engines? L. O. C.

A.—For a pressure per square inch of projected area of bearing of 60 pounds and a peripheral speed of about 550 feet per minute the values should range from .004 to .0055 for good medium-weight oils. Light oils will run about .0035, and heavy oils about .0065.

Formula for Dimensions of Propeller

Q.—Is there any single formula which will permit one to solve for the dimensions of a propeller when the data known are horsepower, speed and revolutions per minute? E. D.

A.—There have been proposed from time to time a number of empirical formulæ based upon experiments on model propellers or analyses of trials of large wheels, but in general the formulæ have been unsatisfactory. Admiral Taylor has just published * a formula which he considers well representative of the results of experiments made at the United States Model Basin with 120 different model propellers. This formula should prove of inestimable value in those cases where a quick solution of reasonable accuracy is desired, but where it is not desirable to take careful account of all factors affecting design. This formula is given below:

Let P denote the horsepower being absorbed by the propeller (indicated horsepower × engine efficiency = P, or shaft horsepower = P).

V denotes speed of advance of the propeller (not ship) through the water in knots.

d denotes diameter of propeller in feet.

a denotes pitch ratio or pitch ÷ diameter.

R denotes revolutions per minute.

For best efficiency—

$$d = \frac{(P\,V)^{1/6}}{R^{2/3}}\left(63.5 - 50\,\frac{V^{5/2}}{R\,P^{1/2}}\right)$$

$$a = 0.74 + 3.3\,\frac{V^{5/2}}{R\,P^{1/2}}$$

$$\text{Efficiency} = 0.768 - 0.01\,\frac{R\,P^{1/2}}{V^{5/2}}$$

If the diameter given by the above proves too large for the case in hand, another propeller should be used of different diameter and less efficiency. If a reduction in efficiency of 2½ percent is accepted, we can then get a wheel to do the same work on a reduced diameter, for which case Taylor gives the following:

For reduced diameter (efficiency 2½ percent less than maximum)—

$$d = \frac{(P\,V)^{1/6}}{R^{2/3}}\left(57 - \frac{50\,V^{5/2}}{R\,P^{1/2}}\right)$$

$$a = 1.08 + \frac{3.3\,V^{5/2}}{R\,P^{1/2}}$$

$$\text{Efficiency} = 0.743 - 0.01\,\frac{R\,P^{1/2}}{V^{5/2}}$$

* Paper before International Engineering Congress, September, 1915, "Calculations for Ship's Forms, etc.," by D. W. Taylor, Chief Constructor, U. S. N.

NEW BOOKS FOR MARINE ENGINEERS

THE STORY OF THE AMERICAN MERCHANT MARINE. By John R. Spears. Size, 5¼ by 7½ inches. Pages, 340. Illustrations, 16. New York, 1915: The Macmillan Company. Price, $1.50.

This book was originally published in 1910 and reviewed in our issue of June, 1910. The new edition is simply a reprint of the book with the addition of an introductory chapter of 27 pages, giving a brief review of the unusual conditions affecting the American merchant marine in the years 1914 and 1915. Briefly, this is a statement of the demoralizing effect of the European war upon the world's shipping at the commencement of the war, and then of the rapid rise in freight rates and the effect of scarcity of tonnage on the movement of freight over seas, and finally a discussion of the proposed remedies for placing the American merchant marine upon a sound basis for permanent growth after the close of the war.

SAILING SHIPS AND THEIR STORY. By E. Keble Chatterton. Size, 6¼ by 8¼ inches. Pages, 362. Illustrations, 130. Philadelphia, 1915: J. B. Lippincott Company. London, 1915: Sidgwick & Jackson, Ltd. Price, $1.50 net.

A comparison of a modern sailing ship (scarce as this type of vessel is at the present time) with the early sailing vessels from which it was evolved through centuries of gradual development is startling. The increase in size, capacity and speed is indicative not only of the wonderful progress in the art of shipbuilding and in mechanical arts, but also of the rapid expansion of commerce between nations. This book is an authoritative history of this subject, told in an entertaining way and pleasingly illustrated. It will be accepted as a standard work.

DIESEL ENGINES: MARINE AND STATIONARY. By A. H. Goldingham. Size, 5 by 7½ inches. Pages, 206. Illustrations, 135. New York, 1915: Spon & Chamberlain. London, S. W., 1915: E. & F. N. Spon, Ltd. Price, $3.

This book is essentially a practical treatise on the Diesel engine, both stationary and marine, giving in concise form descriptions of the various types and designs of this type of engine. In addition to the descriptive matter, which is carefully written and well illustrated with clear line drawings and photographs, there are chapters containing formulæ for the design and construction of the various parts of the engines, as well as a very carefully compiled chapter on operation and correction which is of special value to a marine engineer who is to operate a Diesel engine. Indicator cards, taken from various two- and four-cycle Diesel engines, are reproduced, together with an explanation of their characteristics.

Marine Articles in the Engineering Press

How the F=4 Was Raised—The American Merchant Marine—Trials of New Destroyers and Coast Guard Cutters

Trials of Coast Guard Cutters Ossipee and Tallapoosa.—The trials of the two new cutters for the United States Coast Guard were run on June 22 and June 29, 1915. The two vessels are built to the same lines except that the forward end of the under water body of the *Ossipee* is modified by cutting away the forefoot to enable the vessel to better cope with the winter ice conditions on the Maine coast. Both vessels were fully described in the January, 1915, issue of INTERNATIONAL MARINE ENGINEERING. On the full two-hour, full-power trial of the *Ossipee* the speed developed was 12.55 knots with the engines developing 1,195 indicated horsepower. A speed of 12.66 knots was obtained with the *Tallapoosa* at an indicated horsepower of 1,131. On these trials, which were run in the Hampton Roads and Chesapeake Bay, the *Ossipee* had a displacement of 785 tons and the *Tallapoosa* 748 tons. 1 illustration. 2,800 words.—*Journal of the American Society of Naval Engineers,* August.

The Torpedo.—This article gives a detailed description of the Whitehead type of torpedo now in use in practically every naval department in the world. The development of the Whitehead torpedo is traced from the year 1860, when a Captain Luppis, of the Austrian Navy, conceived the idea of a boat for coast defense, dirigible for a distance and carrying an explosive charge to be fired by a contact device. Captain Luppis became associated with Mr. Robert Whitehead in 1864, and the mechanical development of the torpedo was begun. The modern Whitehead torpedo is described by taking up in succession each of the eight main subdivisions into which the torpedo is divided—that is, percussion or firing device, explosive head, the air chamber containing highly compressed air, balance chamber containing the control gearing, engine room containing driving mechanism, buoyancy chamber, bevel wheel chamber and rudders and propellers. 2 illustrations. 3,700 words.—*The Marine Engineer and Naval Architect,* August.

Twin Screw Steamer Jean Pieterszoon Coen.—The largest steamer so far built in Holland is described as having been built by Ned. Scheepsboun Maatschappy for service to Java, with the dimensions 503 feet 6 inches by 60 feet 4 inches by 39 feet by 25 feet draft and 15,600 tons displacement, 6,950 tons of the latter being available for cargo. She is built according to British Lloyd's with an almost complete double bottom for drinking, ballast and feed water. There are eight watertight transverse and watertight longitudinal coal bunker bulkheads and six decks. Cargo is stowed in five holds and handled by one 25-ton, four 6-ton and two 3-ton booms and eight 2-ton hydraulic cranes. The ship is fitted with two masts and two smokestacks and has fourteen boats, 28 feet by 8 feet 6 inches by 3 feet 6 inches, of which two are motor boats, giving safe accommodation to all passengers and members of the crew. The rudder has double operating gear, one hydraulic-electric and one steam; the watertight doors can be closed by the Stone-Lloyd system; the signal service consists of an underwater sound system and overhead wireless telegraphy. The electric plant of three 200-kilowatt, 115-volt turbo-generators supplies current for the electric light and power for ventilators, wall clocks, Suez Canal searchlights, etc. Passenger accommodations are for 175 first class, 128 second class, 46 third class and 44 fourth class, and 243 members of crew, with luxuriously fitted social rooms, 4 cabins de luxe, 47 single, 60 double cabins, children's dining room, gymnasium, photographic dark room, etc. The machinery plant consists of two engines, 26¾ by 44 by 75 inches diameter by 50 inches stroke, which at 85 revolutions per minute indicate 6,000 indicated horsepower, giving the ship a speed of 15 knots. There are eight three-furnace single-ended boilers of nearly 21,000 square feet heating surface, built for 214 pounds per square inch working pressure. Among the auxiliaries are the usual steam pumps, fire pumps, hydraulic plant, steam winches and windlass, evaporating and refrigerating plant. 11 illustrations. 840 words.—*Schiffbau,* November 19.

Systematic Propeller Tests at the Experimental Basin of the German Government, Berlin.—It is stated that in addition to the tests made with a propeller of an area ratio of 30 percent, tests were made for this series A with those of area ratios of 25, 30, 40, 50 and 60 percent and plotted as functions of the revolution-thrust curve, that means suitable for cases where a certain thrust shall be realized with given revolutions and speed. It is pointed out how the interrelation between areas, efficiencies and thrust varies according to certain given or fixed factors, referring again to a previous numeral example at 30 percent ratio, extending the analysis over the entire range of area ratios and considering at the same time the effect cavitation might have upon practical results. The analysis is carried out also for the entire area ratio in application to tugboat propellers, with the conclusion that their best efficiency is gained from large area and a fine pitch. An appendix contains the mathematical development of the efficiency limit of an ideal propeller. 15 illustrations. 3,540 words.—*Schiffbau,* October 27.

Salvage of the Submarine F-4.—By Naval Constructor J. A. Furer, U. S. N. The first attempts to raise the United States submarine *F-4*, which sank on March 25 at a point about a mile and a half outside of Honolulu harbor, where the depth of water varies from 295 feet to 315 feet, proved fruitless, as the application of an upward pull of about 100 tons by means of a dredge and towing inshore with all the power available failed to move the submarine. The next method of salvage involved the use of two substantially built mud scows, 104 feet by 36 feet, with lifting gear consisting of improvised windlasses actuated by hoisting engines installed on each scow. Two steam-driven pumps were installed on each scow, so that in case it should become necessary to use more power for starting the submarine off the bottom than could be delivered by the hoisting engines, the buoyancy of the scows could be called on. This was necessary only once, however. A dredge from which the boom and bucket gear had been removed was used as the central unit of the salvage plant. The dredge was equipped with a 10-inch by 14-inch engine geared to six drums, any one of which could be operated independently of the other. After innumerable difficulties, two slings were placed under each end of the submarine, but, after lifting the boat about 25 feet and towing inshore to a new landing, one of the hawsers parted; while it was being replaced, bad weather

set in, and presently all of the other hawsers parted. Just one month from the date of the accident not a single line remained around the vessel, and the only measurable progress was a reduction in the depth of water from 300 to 275 feet. Chain slings were substituted for wire slings, and the vessel was lifted 225 feet in a few days and towed inshore to a spot just off the channel entrance, where the depth of water was only 50 feet. A heavy ground swell set in, however, which wrecked the salvage operations. A large rent was found in the hull forward where the chains from one of the scows had ripped through the shell plating. Lifting by the windlass method was then considered unsafe, as it was likely that the forward end of the submarine would break off under the strain. A new plan was accordingly adopted, consisting of the use of six specially constructed pontoon cylinders 32 feet long, four being 11 feet in diameter, and two 12 feet 6 inches in diameter. The combined lifting capacity of the six pontoons was 420 tons. The plan called for the lifting of the vessel by means of six chains. After all six cylinders had been landed on the bottom alongside the vessel and the chains properly secured, the water was forced out of the cylinders by the use of compressed air. This method proved successful in every way, and the vessel was brought to the surface on August 29 and docked the following day. 6 illustrations. 4,300 words.—*Scientific American,* October 16.

The U. S. S. Wadsworth.—The United States destroyer *Wadsworth,* which was authorized by Congress March 4, 1913, was built by the Bath Iron Works, Ltd., Bath, Me. She is a twin screw vessel driven by Parsons turbines fitted with reduction gear and designed for a speed of 30 knots at a displacement of about 1,050 tons with the turbines developing 17,500 shaft horsepower. Steam is supplied by four Normand watertube boilers. The hull is 315 feet 3 inches long overall, 310 feet long on the waterline, 29 feet 8⅛ inches beam on load waterline, mean draft 9 feet 4½ inches, block coefficient, .44. The article gives a general description of the hull; the battery, which consists of four 4-inch rapid fire guns and four 21-inch twin torpedo tubes mounted on the main deck; the steering engine and gear, fire main, flushing system, fresh water system, drainage system, ventilation, heating system and main and auxiliary machinery. The turbines are of the standard Parsons reaction high-speed type, the high-pressure rotor turning at 2,494.5 revolutions per minute and the low-pressure rotor at 1,509.8 revolutions per minute when driving the screws at the designed speed of 450 revolutions per minute. The high-pressure turbines are fitted with cruising stages and the low-pressure turbine with reversing stages. The reduction gears are of Parsons design, each unit consisting of two forged steel pinions forged integrally with their shafts driving a main gear. The main gear is secured to its shaft by bolts, two collars being provided on the shaft for the purpose. It is of the built-up type, consisting of a forged steel rim securely bolted to two steel plate disks forming a wheel, the whole being cross-braced by cast steel cone fitted between the disks and through bolted with the after disk to the rim with the forward disk to its shaft collar The gear and pinions have helical cut teeth. The pinion shafts are direct connected to the turbines, the high pressure turbine driving the outboard pinion and the low pressure turbine the inboard pinion. The gear shaft is coupled direct to the main shaft and on its forward end is fitted the main thrust bearing of the Kingsbury pivoted type. The propellers are 7 feet 7¾ inches diameter and the pitch 8 feet 7½ inches. The trials of the *Wadsworth* were conducted from June 21 to 24, 1915. The contract speed was exceeded without effort and the fuel oil consumption guarantees were improved beyond expectation. On the full-power trial a speed of 30.72 knots was attained with a shaft horsepower of 16,129. The oil burned per knot run at this speed was 506.94 pounds and the water used by the main turbines and condenser augmenter only per shaft horsepower was 11.19 pounds. At a speed of 30.685 and a horsepower of 16,100, the water consumed by all of the machinery per shaft horsepower was 12.533 pounds. 4 illustrations. 8,000 words.—*Journal of the American Society of Naval Engineers,* August.

The Merchant Marine from a Southerner's Viewpoint.—By William Gatewood. The author of this paper, who is naval architect of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., shows along what lines the commerce of the United States has grown so that at the present time its foreign commerce is composed of two distinct parts. Staple products from the abundant natural resources of the country are still exported, but, on the other hand, a large quantity of manufactured products are also exported, which was not the case in former days, when the American merchant marine was carrying most of the country's trade. He points out that the commerce of the United States is likely to save the country from panic and from great general distress until the termination of the present war. And in future the natural resources of the country and the skill of its people in manufactures will make commerce a leading feature in the life of the country. Exports will increase by leaps and bounds and, with increased wealth, imports will increase equally as rapidly. As it is self-evident that the commerce of the United States will continue to grow, it becomes of great imortance that the advantages to be derived from its transportation should be appreciated at their true value. The greatest advantage of the carrying trade probably is the profit which it yields to the country which engages in it. The author cites cases to show that profits will accrue to a country in far greater measure even if Government assistance in the form of a subsidy or in some other manner has to be paid to the operating transportation companies to meet the cost of transportation, as against a lower rate of foreign competitors. The only case in which no saving would be shown in a country on account of carrying its own commerce would be in the case of such a dearth of labor that none could be spared from absolutely essential works in the country. Such a condition does not now exist in the United States, and it is apparent that there is no likelihood of such a condition ever arising, as that is a state of affairs in the infancy of a country or after a national calamity. The beneficial results of spending the money expended for transportation charges in the country which fosters the transportation business is easily shown to be widespread —in fact, almost universal. In view of the fact that under the present conditions assistance must be given to the American merchant marine, the author shows that, while there may be a thousand other ways of granting the necessary assistance, all except the imposition of an additional duty on articles imported in foreign bottoms contemplate taking money from the general public to pay the subsidy or make up the deficit. The advantages of the best method for providing this assistance should be made so that the assistance may be granted in direct proportion to the need. 4,500 words.—*The Journal of the American Society of Marine Draftsmen,* October, 1915.

Shipbuilding and General Marine News

Contracts for New Ships—Marine Terminal Improvements—Recent Launchings—Improved Appliances—Personal Items

Between fifteen and twenty bulk Lake freighters have changed hands in the past few weeks, nearly all being taken over by shippers and consuming interests. Eight bulk freighters have been ordered from Lake shipyards for delivery in 1916, and they will be operated by shippers or managers having connections with ore firms.

The most important deal that has been made in Lake vessel property recently was closed a few days ago when M. A. Hanna & Co. and the Cambria Steel Company, jointly purchased four modern steamships from the Frontier Steamship Company and one from the Niagara Transit Company. These vessels have a combined carrying capacity of about 70,000 tons per trip.

In addition, this firm has recently secured control of four other large steamers.

Contracts for New Ships

The William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., has received contracts from the Mexican Petroleum Company, New York, to build two large oil tank steamships, and also a contract from the Florida East Coast Railway Company, St. Augustine, Fla., to build a duplicate of the car ferry *Henry M. Flagler*.

The New York Shipbuilding Company, Camden, N. J., has a contract from the Coastwise Transportation Company, Boston, Mass., to build a collier of about 8,500 tons deawweight carrying capacity, and a contract from the Pocahontas Navigation Company, New York, to build a large collier.

The Harlan & Hollingsworth Corporation, Wilmington, Del., has received a contract from the Ocean Steamship Company, of Savannah (Savannah Line), New York, to build a large freight and passenger steamship.

The Fore River Shipbuilding Corporation, Quincy, Mass., has received a contract from the Luckenbach Steamship Company for the construction of two additional 10,000-ton freight steamers to be delivered in about twenty-four months. With the present contracts, the Luckenbach Company has placed orders calling for no lass than five new 10,000-ton steamers, some of which are nearing completion.

The Maryland Steel Company, Sparrows Point, Md., has received a contract to build two large vessels for a Cuban Ore Company.

The Great Lakes Engineering Works, Detroit, Mich., has received a contract to build two new ships designed by George Simpson, naval architect, New York, for Adler, Inc., of Birmingham, Ala.

Orders for four new motor-propelled ships of 3,500 tons each, to be delivered next autumn at a price of $200,000 (£41,000) each have been placed at Baltimore.

The New York Navy Yard has received the contract for the United States super-dreadnought No. 43, to be built at a cost of $7,690,925 (£1,575,000).

The Mare Island Navy Yard, California, has received the contract for building the United States super-dreadnought No. 44 at a cost of $7,413,156 (£1,520,000).

The Harlan & Hollingsworth Corporation, Wilmington, Del., has received a contract from the Vacuum Oil Company for an oil tanker of 50,000 barrels capacity, and also for a freight steamer with a capacity of 3,500 tons of general cargo.

The Union Iron Works, San Francisco, Cal., has received a contract from the Vacuum Oil Company for an oil tanker with a capacity of 75,000 barrels.

The Canadian Government has decided to give every possible encouragement to the building of ships to accommodate the British Columbian lumber trade. An issue of bonds is to be authorized by the government to provide for building thirty four-masted ships to be turned over to the lumber manufacturers of British Columbia, who will pay for the ships as the bonds fall due. Enough bonds have already been subscribed to lay the keels of six of the new ships in the spring.

The American Shipbuilding Company, Cleveland, Ohio, has received a contract from M. A. Hanna & Co., Cleveland, to build a 524-foot steamship of about 9,500 tons capacity. This order makes eleven steamships that the American Shipbuilding Company has under contract for delivery in 1916.

The Newport News Shipbuilding & Dry Dock Company, Newport News, Va., has received a contract from the Southern Pacific Company, New York, to build two freight steamships and one oil tank steamship, and also from another source a contract to build another oil tank steamship. Including the above orders, the Newport News Shipbuilding & Dry Dock Company has received contracts this year to build twenty-four steamships, exclusive of naval orders.

The Maryland Steel Company, Sparrows Point, Md., has received a contract from the Munson Steamship Line, New York, to build a passenger steamship. This makes the third steamship which the Munson Line has recently ordered of the Maryland Steel Company.

The Union Iron Works Company, San Francisco, Cal., has received a contract to build two oil tank steamships 435 feet long, and also a contract from another concern to build an oil tank steamship 435 feet long.

The Collingwood Shipbuilding Company, Collingwood, Ont., has received a contract from the Montreal Transportation Company, Montreal, Canada, to build a 550-foot freight steamer.

Joseph Supple, Portland, Ore., has received a contract from the Kitsap Transportation Company, Seattle, Wash., to build a 150-foot river boat.

Whittlesey & Whittlesey, naval architects, New York, have designed a 200-foot steel passenger steamship to be operated in the vicinity of New York.

Nilson & Kelez, Seattle, Wash., have received a contract from the Pacific American Fisheries Company, Bellingham, Wash., to build a light draft twin screw freight boat 100 feet long, to be equipped with two 80-horsepower oil engines.

The Kelley-Spear Company, Bath, Me., will build two derrick lighters for the New England Steamship Company, Boston, Mass.

The Matthews Shipyard Company, Hoquiam, Wash., will build a wooden steam lumber schooner for the S. S. Freeman Steamship Company, San Francisco, Cal.

The Tietjen & Lang Dry Dock Company, Hoboken, N. J., will rebuild the steamship *Dunholme*, belonging to the Merritt & Chapman Derrick & Wrecking Company, New York.

The Standard Shipbuilding Company, West Brighton, Staten Island, which recently purchased and is now operating the shipbuilding yard of the old Shooters Island Company, is stated to have received orders to build four 6,000-ton freight steamers.

The Continental Trading Company, Mystic, Conn., a new shipbuilding company, is reported to have received orders to build three steamers for Norwegian interests.

Shipbuilding Contracts Pending

The city of Astoria, Ore., is planning to operate boats from that city to Lewiston, Idaho, and it is said that work will shortly be started on the construction of the boats to navigate the Columbia and Snake rivers. The work is in the hands of Captain Arthur Riggs, of Astoria.

The Department of Commerce and Labor, Washington, D. C., will soon advertise for bids for a lobster vessel to be used on the coast of Maine. The appropriation available is $45,000 (£9,200).

It is announced that the Southern Pacific Company, New York, will shortly order another large tank steamship.

The Port of Seattle (Wash.) Commission, J. R. West, chief engineer, contemplates building a ferry steamer to cost $30,000 (£6,150).

Shipyards on the North Pacific coast have been asked for bids to build twelve barges, 130 feet by 34 feet by 9 feet, having a capacity of 300 tons and six gasoline (petrol) tugs, two of 80 horsepower, four of 50 horsepower, and four smaller power barges to be equipped with machinery for harvesting seaweed from Alaskan coast waters.

The Midvale Steel & Ordnance Company, Philadelphia, Pa., is reported to have purchased extensive iron ore deposits in Cuba, and in connection with this project it is stated that the company contemplates the building of steamers to ply between Cuba and Atlantic ports.

New 11,500-Ton Werkspoor-Engined Ship

The steamship *Ombilin* was recently launched by the Netherlands Shipbuilding Works to the order of the Royal Packet Steamship Company, which already owns four Werkspoor-Diesel-engined ships, the low operating costs of which recently were published. The new vessel is to the highest class of the Bureau Veritas, and is the largest of the company's fleet. In addition, she is the first ship to be fitted with topside tanks ever built in Holland. Her dimensions are 420 feet by 54 feet by 27 feet, displacement 11,500 tons on 22 feet 6 inches draft. The accommodations for officers, engineers and crew are aft. She has four large, clear holds without 'tweendecks or beams.

All latest improvements for expeditiously handling the cargoes have been fitted, including 16 steam winches and derricks for lifting 30 tons. Her steam windlass is of the Clarke-Chapman type, and the steam steering gear of the Donkin type. The machinery is being supplied by the Netherlands Engineering Company (Nederlandsche Fabriek van Werktuigen en Spoorwegmaterieel), of Amsterdam, builders of the Werkspoor-Diesel engines. The engines are of the triple expansion type, with cylinders 24½ inches, 40½ inches and 67 inches diameter by 48 inches stroke. She will have three single-ended Scotch boilers, working under a pressure of 180 pounds per square inch, fitted with Howden's forced draft.

Shipyard Extensions and Improvements

It is stated that the Union Iron Works, San Francisco, Cal., will build a floating dry dock and make other improvements at a cost to exceed $1,000,000 (£205,000).

It is reported that the Texas Oil Company has purchased the shipbuilding plant of Arthur Sewall, Bath, Me., and will shortly commence the construction of a fleet of twenty steel barges for transporting oil in bulk.

The Morse Dry Dock & Repair Company, Brooklyn, N. Y., is planning to build the largest sectional floating dry dock in the country at the foot of Fifty-eighth Street, Brooklyn. It is said that this dock will have a lifting capacity of 27,000 tons.

The St. Helens Shipbuilding Company, St. Helens, Ore., is considering enlarging its plant to enable the company to lay down steel hulls with a maximum length of about 350 feet.

The plant of the John H. Dialogue Company, Camden, N. J., was sold at auction on December 8, to interests which, it is reported, will reorganize the company and reopen it for shipbuilding purposes.

It is reported that the Bethlehem Steel Company, South Bethlehem, Pa., is planning to build a large shipyard at Newcastle, Del.

Contracts for Piers, Wharves and Marine Terminal Improvements

The Link Belt Company, Chicago, Ill., has received a contract from the Gulf, Florida & East Coast Railway, Pensacola, Fla., to build a coal pier at Pensacola.

O. L. Olesen, 133 Moraine Road, Highland Park, Ill., has received a contract to build piers at Evanston, Ill.

The Duluth & Iron Range Railway Company, Duluth, Minn., is reported to be planning to build two ore docks at Two Harbors, Minn., at an estimated cost of $1,500,000.

It is reported that the Pennsylvania Coal & Supply Company, Milwaukee, Wis., will build new docks at Muskegon avenue and Canal street, Milwaukee.

The city of Chattanooga, Tenn., R. Hooke, city engineer, is planning to improve its wharves and to issue $100,000 (£20,500) in bonds for that purpose.

It is reported from San Francisco, Cal., that a contract will soon be awarded to build a pier at the foot of Chestnut street, to cost about $250,000 (£51,300).

It is reported that the New York Dock Company, foot of Montague street, Brooklyn, N. Y., will spend about $1,250,000 (£256,000) in wharves and piers on the Brooklyn water front.

The Board of Port Commissioners of New Orleans, La., will construct some new wharves. Plans and specifications are on file with Ford, Bacon & Davis, New Orleans.

It is announced that J. J. Kane, Galveston, Tex., will spend about $1,000,000 (£205,000) on a dry dock in Galveston harbor instead of $500,000 (£102,500) as at first planned.

The Minneapolis, St. Paul & Sault Ste. Marie Railroad, C. N. Falk, chief engineer, Minneapolis, Minn., has prepared plans for a large concrete ore dock at Ashland, Wis.

Snare & Triest, Woolworth Building, New York, will build a pier at Deep Water Point, Wilmington, Del., for the Dupont Powder Company, Wilmington.

The Charleston Engineering & Construction Company, Charleston, S. C., has received a contract amounting to $55,000 (£11,300) to build a wharf at Tradd street, Charleston.

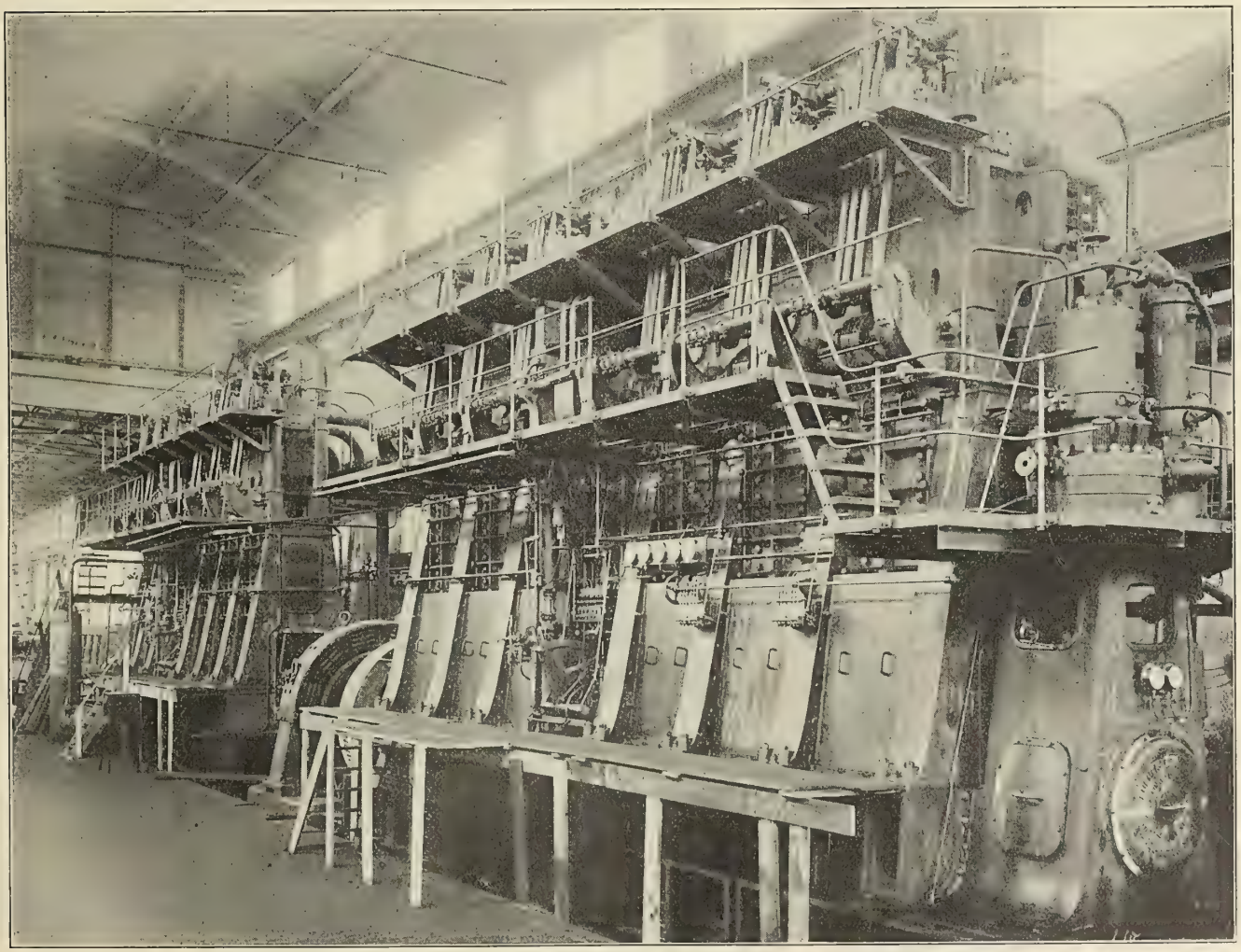
The city of Houston, Texas, is planning to spend $1,000,000 (£205,000) for wharves and piers next year.



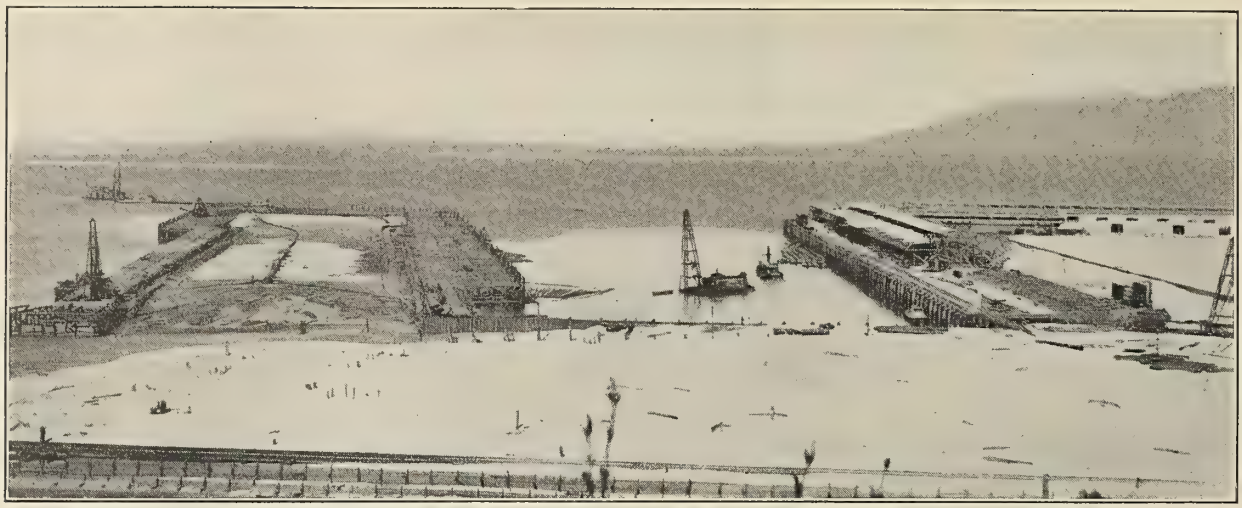
Motor Ship *Australien*, Built by Burmeister & Wain for the East Asiatic Company

During the past two years the city of New York, through Commissioner of Docks and Ferries, R. A. C. Smith, Pier A, New York, has begun work on almost seven miles of wharfage space. These new piers will furnish 1,973,000 feet of dock space. Among the improvements are the 1,050 foot piers at Forty-fourth street and Forty-sixth street, North River, which will accommodate the largest liners now afloat or to be built for many years to come.

The city of Beaumont, Tex., has let a contract to John O. Kelley, of Beaumont, to build a 500-foot concrete wharf at a cost of about $60,000 (£12,300).



Six-Cylinder, Four-Stroke, Single-Acting Diesel Engines for the Motor Ship *Australien*



Rail and Water Terminals Under Construction at the Mouth of the Columbia River at the Port of Astoria

The Erie Railroad Company, New York, will build ore docks at Cleveland, Ohio, to cost about $200,000 (£41,000).

The Merchants and Miners Transportation Company, Baltimore, Md., has given the contract to the Hillyer & Spearing Company, Jacksonville, Fla., for dock improvements at Jacksonville to cost $75,000 (£15,400).

The Barnett & Record Company, Duluth, Minn., will build a $90,000 (£18,400) dock for the M. A. Henner Coal Company.

The General Chemical Company, Marcus Hook, Pa., has awarded a contract to John Monks & Sons, New York, to build a pier at a cost of $200,000 (£41,000).

Ford, Bacon & Davis, contracting engineers, New Orleans, La., are drawing plans for construction of docks, terminals, etc., for the city of Mobile, Ala.

Doullutt & Williams, New Orleans, La., will build a grain elevator wharf for the Port Commissioners of New Orleans, at a cost of $188,000 (£38,500).

The city of Miami, Fla., received bids until December 20 for the construction of piers and other improvements. Isham, Randolph & Co., Chicago, Ill., are the engineers.

John O. Kelly, San Antonio, Tex., will build a wharf for the city of Beaumont, Tex., at a cost of $65,000 (£13,300).

The Baltimore & Ohio Railway Company, F. L. Stuart, chief engineer, Baltimore, Md., has awarded contracts for constructing and equipping a coal pier at Curtis Bay to H. S. Kerbaugh, Inc., Baltimore, Md.

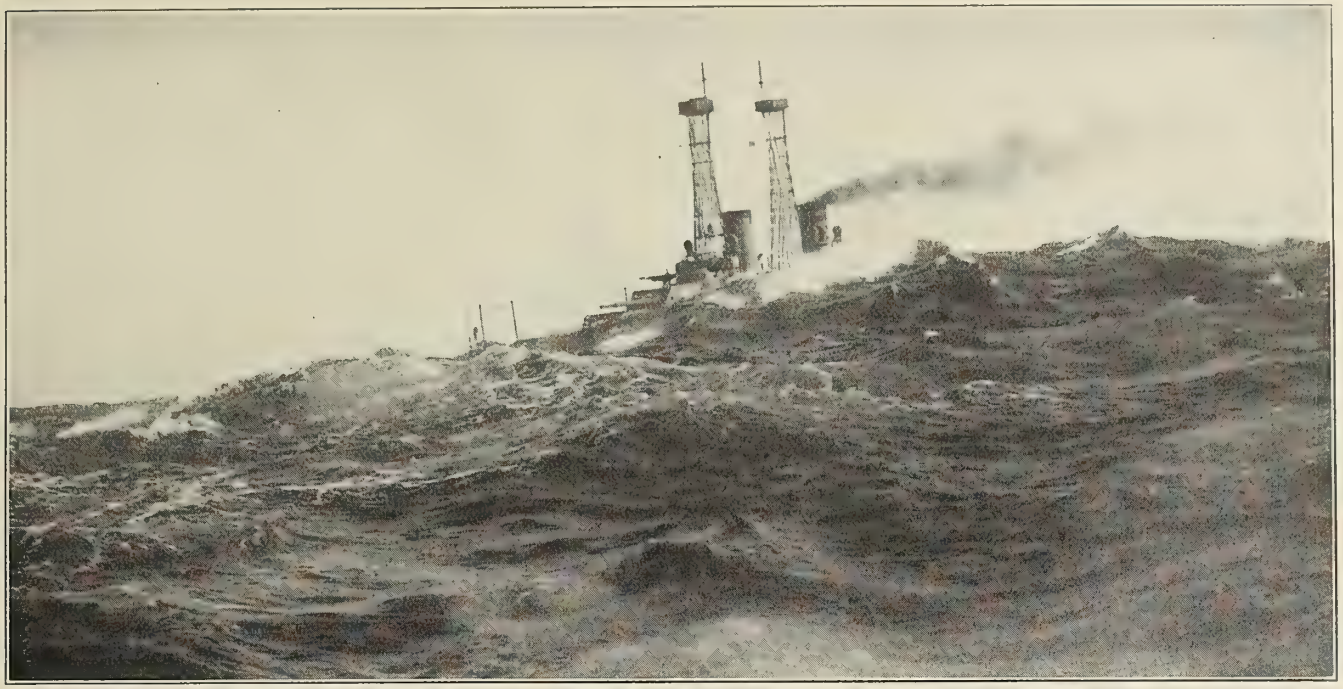
The American Bridge Company, New York, has been awarded a contract to build the superstructure of the concrete ore dock for the Duluth & Iron Range Railway Company, Duluth, Minn., at Two Harbors, Minn., at a cost of about $1,635,000 (£336,000).

Launch of Collier Bylayl

The New York Shipbuilding Company launched at Camden, N. J., on December 4 the collier *Bylayl* for the Pocahontas Navigation Company. The vessel is of the same type as the *Norfolk,* built by the New York Shipbuilding Company for the Coastwise Transportation Company, and is 319 feet long between perpendiculars, 49 feet 3 inches beam molded, 27 feet 6 inches depth molded, and with a draft of 22 feet 8 inches has a deadweight carrying capacity of 5,450 tons. The propelling machinery, which is placed aft, consists of a triple expansion engine of 1,800 indicated horsepower, supplied with steam at 200 pounds pressure by two-single-ended Scotch boilers. The designed speed at sea loaded is 10½ knots.



S. S. *Franklin,* Seventh Collier Built by the New York Shipbuilding Company for the Coastwise Transportation Company, Boston, Mass.



United States Battleship *Delaware*, Ploughing Through the Heavy Seas of the North Atlantic

Trials of Motor Ship Columbia

The official trials of the motor ship *Columbia,* built by Burmeister & Wain for the East Asiatic Company, were carried out in Copenhagen Sound last month. Like the *Australien,* illustrated on page 41, and the other sister ships of the East Asiatic Company's fleet of motor ships, the *Columbia* is 425 feet long between perpendiculars, 55 feet beam, 30 feet 6 inches depth, with a deadweight carrying capacity of 9,500 tons on a draft of 26 feet 5 inches. The main Diesel engines develop 1,550 indicated horsepower at 125 revolutions per minute, which gives the ship a speed of 11.15 knots.

The auxiliaries are driven by electricity generated by three two-cylinder auxiliary Diesel engine sets of 90 brake horsepower each.

During the trial trip a speed of 12.05 knots was attained at 3,315 indicated horsepower at 142 revolutions per minute. The fuel consumption of Solar oil was .31 pound per indicated horsepower hour for all purposes.



United States Coast Guard Cutter *Seneca* Passing Between Two Large Icebergs While Patroling the North Atlantic Steamship Lanes

ENGINEERING SPECIALTIES

Savings Made by Oxy-Acetylene Cutting Torch

The wrapper sheets in three boilers on the steamship *H. M. Whitney,* of the Eastern Steamship Company, were cut out recently at Boston, Mass., by two men in six days



Cutting Out Wrapper Sheet in Boiler on Steamship *H. M. Whitney* with Imperial Oxy-Acetylene Torch

of eight hours each by means of oxy-acetylene cutting torches. The superintendent of the company states that this work would ordinarily take nine boiler makers and helpers eighteen days if the job were done by hand. Nine men working eighteen days would make a total of 1,296 hours. On the other hand, two men working with a torch for six days at eight hours each equals ninety-six hours. Hence there is a total saving of 1,200 working hours on this job. Figuring the average wage of boiler maker and helper at 40 cents (1/8) per hour, which is very low, there is a saving of $480 (100/0/0) on this one job.

The oxy-acetylene cutting apparatus used in this case was supplied by the Imperial Brass Manufacturing Company, Chicago, Ill.

120-Horsepower 4-Cylinder Nlseco Diesel Engine

The New London Ship & Engine Company, Groton, Conn., has placed on the market a vertical, single-acting, four-cylinder Diesel engine of the four-cycle type, which is rated at 120 horsepower. The details of construction of this engine are similar in every respect to those of the 60-horsepower Nlesco Diesel engine described in our November issue. Reversing is obtained by means of a heavy duty type of mechanical reverse gear and clutch. This reverse gear is shown in the photographs, Figs 2 and 3, but is not shown in the drawing, Fig. 4.

The engine has four working cylinders, 9 inches diameter and 12½ inches stroke, and develops 120 horsepower at 350 revolutions per minute. At the forward end of the engine there is a two-stage tandem-type air compressor



Fig. 1.—Cannery Tender *Chomly*

for supplying air for injecting the fuel and for starting purposes, provision being made for regulating the pressure carried on the spray air by means of a throttle on the first stage suction. The weight of the engine complete with flywheel, clutch and thrust bearing is about 16,500 pounds.

A number of these four-cylinder 120-horsepower engines have already been built and installed, and the owners report that their performance has been uniformly satisfactory. An example of the economy, reliability and remarkably light cost of upkeep of one of the engines is

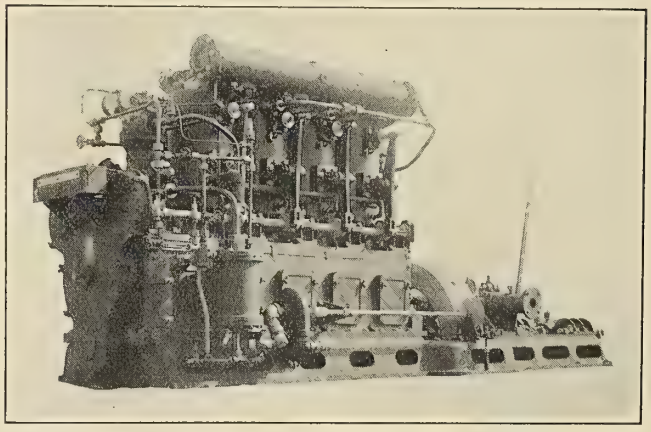


Fig. 2.—Exhaust Side of the Engine

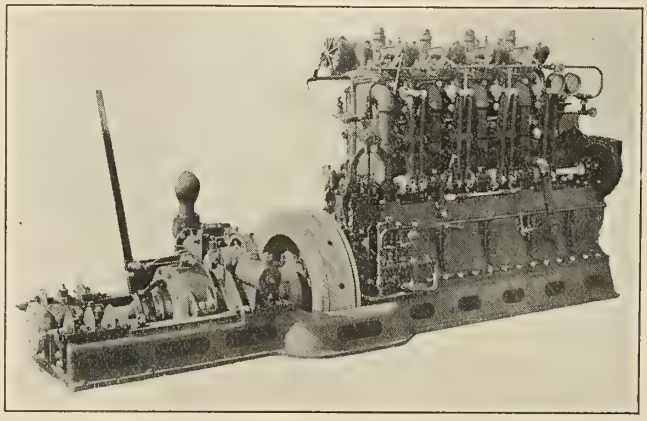


Fig. 3.—Working Side of the Engine

summed up in the following: The cannery tender *Cholmy*, a boat 78 feet long, 18 feet beam and 8 feet depth, heavily built on towboat lines, owned by the Alaska-Pacific Fisheries, of Seattle, Wash., and Portland, Ore., is equipped with such an engine. The boat went into commission May 13, 1915. Her first run from Seattle, Wash., gallons of fuel oil was consumed, this being at the rate of 5.8 gallons per hour, which, at the price of fuel oil at Seattle (95 cents per barrel) gives a roughly running cost for this vessel of 13.1 cents, or a total fuel bill for the season of $195.97 (£40). During the entire season the only expenditure for repairs amounted to only $2 (8/4).

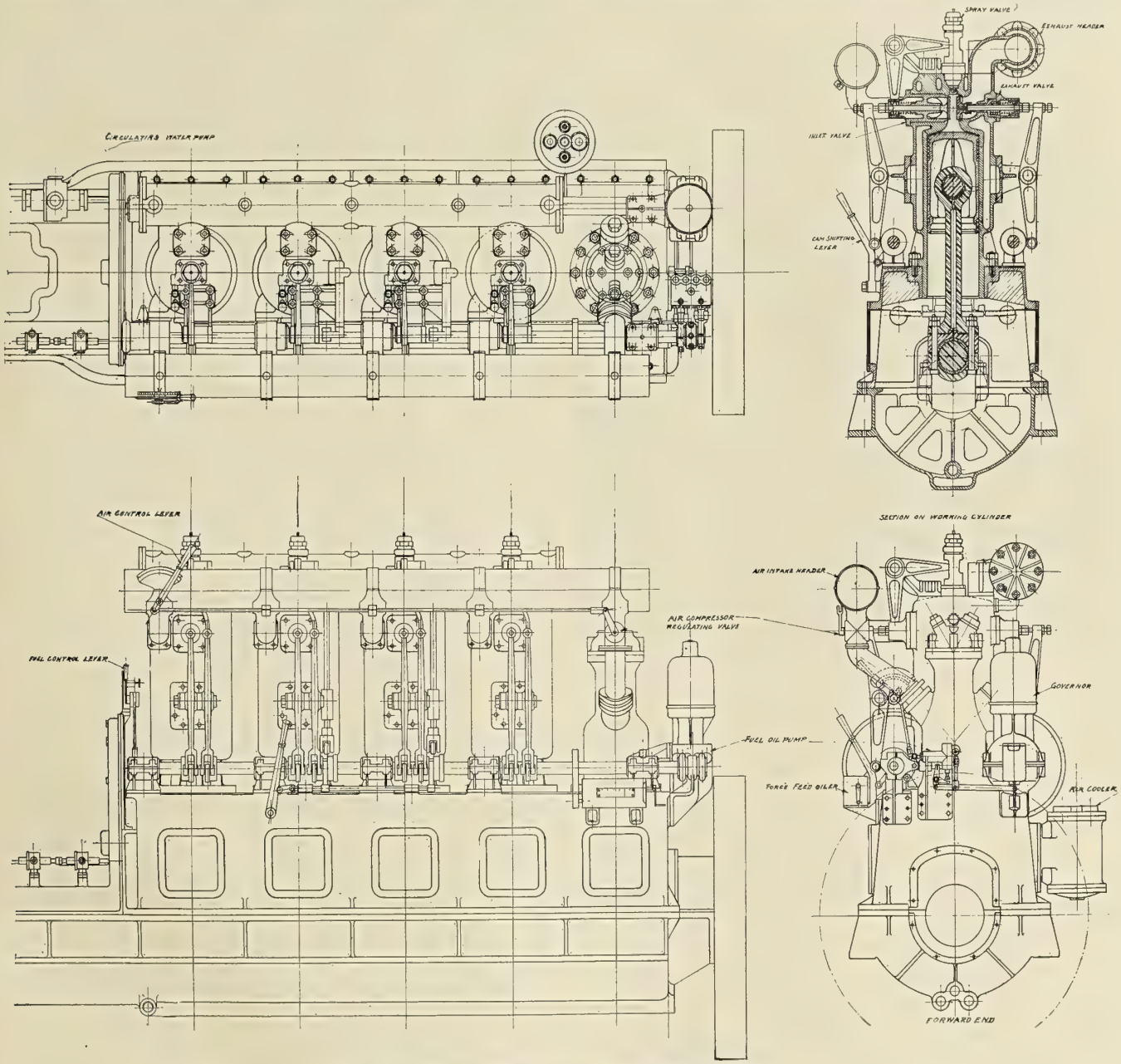


Fig. 4.—Nlseco 120 Horsepower Diesel Marine Engine

to Ketchikan, Alaska, a distance of 754 miles, was made in 882 hours, the engine burning only 6 gallons per hour of 2¼-cent fuel oil, making a cost of 13½ cents per hour for fuel. The cost of lubricating oil was 2⅔ cents per hour, making the combined fuel and lubricating cost 16 1/6 cents per hour.

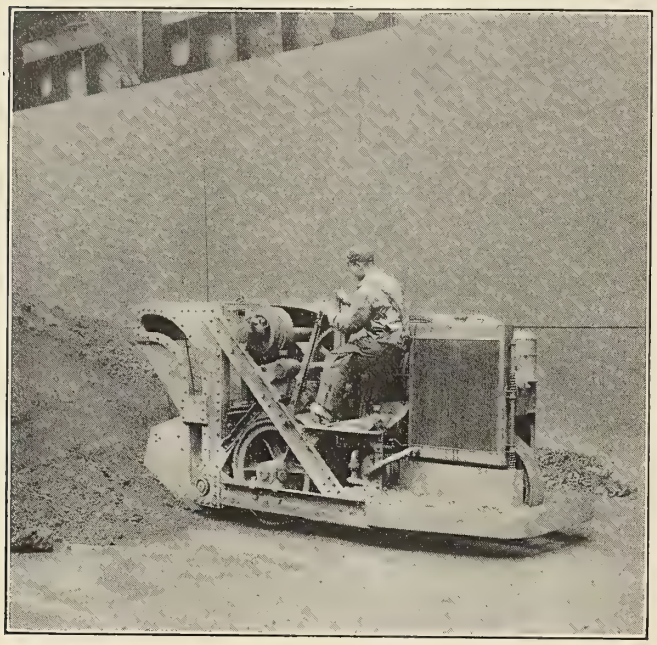
In the North the *Cholmy* operated from the Cholmy, Alaska, cannery for four and a half months, doing heavy duty work in towing scows, pile drivers and brailing fish at the traps. Having finished her season's work in the North, the *Cholmy* made a return non-stop run of 754 miles, arriving at Seattle in splendid condition. The engine room log of the *Cholmy* shows for the season a working time of 1,989 hours, during which a total of 8,664

Power Scraper Shovel for Handling Bulk Cargoes in Holds of Vessels

In unloading boats of ore or coal there is always a certain amount of material that lies between the hatches and cannot be reached by the unloading grabs. The "Brownhoist" power scraper shovel illustrated, which was developed by Mr. S. J. Russell, dock superintendent on the Buffalo, Rochester & Pittsburgh Railroad Company's dock at Buffalo, and is now manufactured by the Brown Hoisting Machinery Company, Cleveland, Ohio, is designed to place this material between the hatch openings, thereby doing away with hand shovelers.

The "Brownhoist" power scraper shovel consists of a high-powered gasoline (petrol) engine operating a shovel

located at the front end of the machine. When the shovel is raised to its top limit it is in a dumping position and the load falls out. The entire mechanism is mounted on two rubber-tired driving wheels with a third wheel in the rear as a trailer and steering wheel. The two driving wheels are connected to the engine by means of gearing and clutches so as to move the shovel back and forth. The hoisting drums for raising the shovel and dumping it are also connected to the engine through gearing and clutches. All operations are controlled by the operator by means of levers in front of his seat. Brakes are supplied so as to give the operator better control of the operation.



Brownhoist Power Scraper Shovel at Work in Hold of Steamer

When handling ore or coal in the hold of a vessel the shovel pushes the material to the desired point instead of picking up a shovelful at a time and depositing it there. This makes the operation much faster, as more material than one shovelful is handled at each trip. When working in the bow or stern, or against bulkheads, it is necessary to handle the material a shovelful at a time, carrying the material to the hatch. In this work the power shovel effects a marked saving of time over hand shoveling. From the results obtained in service, it is found that a vessel is released anywhere from one to five hours sooner than when hand shovelers are used. It saves the cost of from 12 to 40 shovelers, depending on the type of boat.

Babcock & Wilcox Watertube Boilers to be Installed in New Vessel for the Matson Navigation Company

The Babcock & Wilcox Company has recently received an order from the Matson Navigation Company of San Francisco for eight large boilers and superheaters for their new passenger and freight ship now building. This vessel will operate between San Francisco and Honolulu, and will be a companion vessel to the *Matsonia,* which has been in operation for several years. It is expected that the power developed on the new vessel will be approximately 11,000 horsepower.

The Matson Navigation Company purchased Babcock & Wilcox boilers for their tug *Navigator* in 1907, and the success of the boilers on this small vessel (which first proceeded to San Francisco from Newport News under her own steam, and then went into service between that port and Honolulu) was such as to warrant the installation of Babcock & Wilcox boilers in 1912 in the *Matsonia,* a vessel of 10,000 tons displacement.

In the *Matsonia,* however, it was considered advisable to install three Scotch boilers in addition to the six Babcock & Wilcox boilers, the idea being that the Scotch boilers would be better adapted for handling deck winches and other auxiliary machinery in port. It was found, however, as soon as the vessel went into commission (that is, when loading the first cargo), that the Babcock & Wilcox boilers were even better adapted for handling the deck winches than the Scotch boilers, and the latter were used only as spares, or to assist in developing maximum power in combination with the six Babcock & Wilcox boilers when in free route. It was a natural development, therefore, that Babcock & Wilcox boilers and superheaters should be used entirely in the new ship.

This is not the first time that Babcock & Wilcox boilers have been tried in combination with Scotch boilers on account of the prejudice existing in some quarters against watertube boilers in the merchant service. The coast guard cutter *Snohomish* was fitted with one Babcock & Wilcox boiler and one Scotch boiler, but experience showed on that vessel, as elsewhere, that the Babcock & Wilcox boiler was more economical in the expenditure of fuel, and that the cost of repairs and maintenance was materially less than for the Scotch boiler. Incidentally, also, in this vessel the power developed was greater with the Babcock & Wilcox boiler. Since the installation on the *Snohomish,* fifteen other coast guard cutters have been fitted with Babcock & Wilcox boilers to the entire exclusion of the Scotch type.

OBITUARY

Arthur E. Meyer, associated with D. B. Dearborn & Co., New York, died on December 4 in San Francisco, Cal., aged thirty-four.

Edward Smith, president of the American Shipbuilding Company, and of the Buffalo Dry Dock Company, died in Buffalo, N. Y., on December 5, aged seventy-one.

Henry R. Roper, chairman of the Leyland Steamship Line and a vice-president of the International Mercantile Marine Company, died recently in Liverpool, aged fifty-five.

Lucien Maxwell Brigham, a widely known machinery manufacturer and one of the directors of Manning, Maxwell & Moore, New York, died recently at his home in Orange, N. J., aged forty-two.

F. O. Smith, president and general manager of the F. O. Smith Shipbuilding & Dry Dock Company, Norfolk, Va., died at his home in Norfolk on November 19, aged fifty-three. Mr. Smith was president of the Board of Harbor Commissioners.

Leopold Katzenstein, head of the firm of L. Katzenstein & Co., and prominently identified with the marine engineering field for the past forty-five years as an inventor and manufacturer of steam engineering specialties, died on December 6 in New York, aged seventy-six.

James Mapes Dodge, president of the Link Belt Company, Philadelphia, Pa., died on December 4 at his home in Germantown, Pa., of pleurisy and pneumonia, aged sixty-three. Mr. Dodge was vice-president of the Franklin Institute, a former president of the American Society of Mechanical Engineers, and widely known as an engineer in the development of mechanical conveying machinery.

PERSONAL MENTION

Operating Engineers

J. M. Dougal has been appointed assistant engineer of the steamer *Reaper,* vice Everett Moats, resigned.

Melvin Leap, of Cincinnati, Ohio, has been appointed chief engineer of the river steamer *J. M. Ware,* vice M. Ellis, resigned.

Samuel Ellis, of Cincinnati, Ohio, has been appointed chief engineer of the river steamer *Hercules,* vice Arthur Doty, retired.

F. W. Ingram, a former marine engineer of Paducah, Ky., is associated with the Ingram-Tarleton Engineering Company, of Macon, Ga.

Hugh L. Edwards was appointed chief engineer of the steamer *Reaper* upon its recent arrival at Paducah, Ky., vice van Petty, resigned.

Monroe Fitzpatrick, of Cincinnati, Ohio, has been appointed chief engineer of the steamer *Lucinda,* with Richard Simms as first assistant.

William van Hoosen, chief engineer of the lumber district plant of the Great Lakes Dredge & Dock Company, Albany, N. Y., has resigned.

James Rhea, of Paducah, Ky., has been appointed chief engineer of the river steamer *Weenona,* with George Lendler as assistant engineer.

B. D. Bridenbaugh, of Paducah, Ky., has shipped as second engineer on the steamer *Golden Fleece,* of which W. D. Hardesty is chief engineer.

J. H. Reynolds, of Paducah, Ky., has been appointed chief engineer of the river steamer *Clyde.* A. L. Patmor is assistant engineer of this vessel.

George W. McNeese, of Paducah, Ky., has been appointed chief engineer of the steamer *Blue Spot,* with James G. Grimes as assistant engineer.

V. A. Hutchinson, of Paducah, Ky., has been appointed assistant engineer of the river steamer *North Star.* J. L. Weston is chief engineer of this vessel.

Robie Reynolds, of Paducah, Ky., for some time has had charge of the engines of the steamer *White Spot,* belonging to Captain William Berry, of Paducah.

John Pemberton, of Paducah, Ky., has assumed the duties of chief engineer of the steamer *Sidney* and will have the vessel ready for service on January 1.

Ambrose van Wie, formerly with the Great Lakes & Dock Company, Albany, N. Y., has been appointed chief engineer of the Barnett-Shoddy Company's plant at Albany, N. Y.

L. F. Taylor, formerly chief engineer of the river steamer *Lucinda,* has been appointed chief engineer of the plant of the American White Oak Leather Company, Cincinnati, Ohio.

William Washburn has been appointed chief engineer of the steamer William H. Kinch, of the Great Lakes Dredge & Dock Company, Albany, N. Y., vice Henry van Loan, resigned.

Peter Deitz, chief engineer of the harbor tug Robert N. Day, owned by the Davis Contracting Company, Albany, N. Y., was severely burned when the tug caught fire near Lagoon Island on December 10.

Captain John D. Silliman, one of the best known river men on the Hudson River, suffered a stroke of paralysis on the towboat *E. M. Levy,* at Castleton, N. Y., on December 5. Captain Silliman died on being brought to his home in Rensselaer, N. Y.

Henry Gates, formerly assistant engineer of the United States Government tug *General Totten,* has been appointed chief engineer of the United States Government tug *Colonel Thayer,* of the Albany-New York district, vice Samuel J. Ryan, resigned.

Changes in United States Steamboat Inspection Service

Howard N. Taft has been appointed assistant inspector of boilers, United States Steamboat Inspection Service, at Boston, Mass.

Martin Walle has been appointed assistant inspector of hulls, United States Steamboat Inspection Service, at Milwaukee, Wis.

Richard F. Bailey has been appointed local inspector of boilers, United States Steamboat Inspection Service, at Galveston, Texas.

William H. Gilman, formerly assistant inspector of boilers, United States Steamboat Inspection Service, at Boston, Mass., has been promoted to local inspector of boilers, succeeding Andrew Savage, resigned.

Gustav E. Atkinson, assistant inspector of hulls, United States Steamboat Inspection Service, at Milwaukee, Wis., has been promoted to local inspector of hulls at Chicago, vice Ira B. Mansfield, deceased.

Naval Architects, Consulting Engineers, Draftsmen, and Shipyard and Steamship Officials

Captain C. N. Dyson, U. S. N., was elected president of the American Society of Naval Engineers on December 30.

Dr. David S. Jacobus, advisory engineer of the Babcock & Wilcox Company, New York, has been elected president of the American Society of Mechanical Engineers.

Robert Bruce Steward has been appointed New York representative for the Marten-Freeman Davit Company, with offices in 17 Battery Place, New York, taking the place of the late C. J. Hale.

Louis L. Bernier, New York representative of the boiler department of the Kingsford Foundry & Machine Company, of Oswego, N. Y., has also been appointed marine agent of the Diamond Power Specialty Company, of Detroit, Mich.

Merton E. Farr, of Detroit, Mich., has been elected president of the American Shipbuilding Company, succeeding the late Edward Smith. O. J. Fish, formerly secretary and treasurer of the company, succeeds Mr. Farr as vice-president.

F. P. Palen, assistant to the president of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., was elected vice-president of the company on December 7. Mr. Palen's headquarters are at the New York office of the company.

Miller Reese Hutchinson, E. E., Ph. D., chief engineer to and personal representative of Mr. Thomas A. Edison, has been appointed by the Secretary of the Navy a member of the Naval Consulting Board and also as assistant to Mr. Edison, chairman of the Board.

Prof. C. H. Peabody, in charge of the Department of Naval Architecture and Marine Engineering at the Massachusetts Institute of Technology, Boston, Mass., has recently received notice from Baron Chinda, Japanese ambassador to Washington, that the Emperor of Japan has conferred upon him the Imperial Order of the Rising Sun, third class.

SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

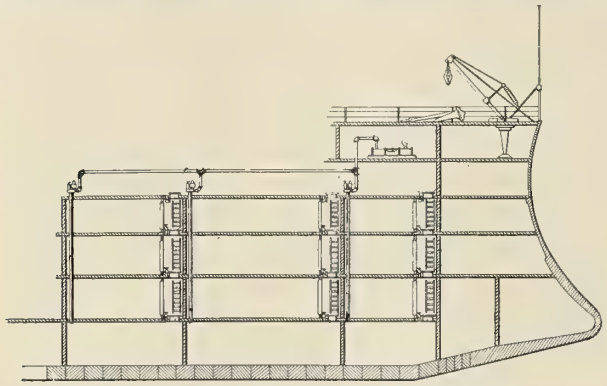
American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,150,799. METHOD OF INDICATING A SHIP'S APPROACH AND MEANS THEREFOR. EDWARD C. WOOD, OF SOMERVILLE, MASS., ASSIGNOR TO SUBMARINE SIGNAL COMPANY, OF WATERVILLE, MAINE, A CORPORATION OF MAINE.

Claim 1.—That method of submarine signaling which consists in disturbing a submerged electrically-generated magnetic field by the approach thereto of a body of magnetic metal whereby the electric current forming the source of said field will be disturbed, and causing the disturbance of said electric current to influence an indicating instrument. 3 claims.

1,149,709. AIR-PRESSURE SYSTEM AND METHOD OF OPERATION. WILLIAM WALLACE WOTHERSPOON, OF NEW YORK, N. Y.

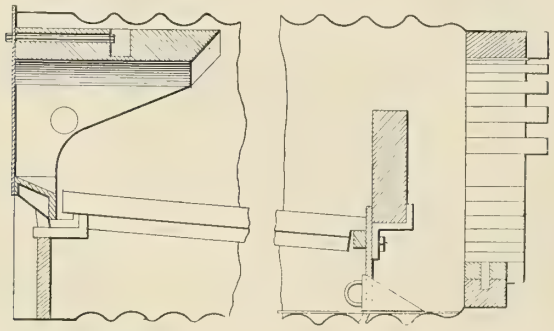
Claim 1.—The method of applying air pressure to ships' compartments to expel water from a leaking compartment and to reinforce said compartment against strains due to internal pressure, which method con-



sists in applying different degrees of air pressure internally to the leaking compartment and surrounding compartments respectively, said pressures being predeterminately selected so that the leaking compartment will receive sufficient pressure to expel water therefrom, and the other compartments will receive a relatively lower pressure to reinforce the walls of the leaking compartment against strains due to the higher pressure therein. 14 claims.

1,154,153. MARINE-FURNACE EQUIPMENT. ALFRED B. WILLOUGHBY, OF PHILADELPHIA, PENN.

Claim 1.—In a furnace, the combination with a front, a dead plate extending across the front, and supports mounted on the dead plate, a one-piece refractory arch having its terminals mounted on the supports and having its central portion extending inwardly from the supports and provided with a centrally lined recess disposed substantially midway



between the front and back edges of the arch, the arch further having an opening extending from the recess through the front; and a single supporting means for preventing inward movement of the arch comprising a straight bolt held in said opening and extending through the front, the head of said bolt bearing against the front, and a nut on the bolt within the recess and engageable with the front wall of the recess.

1,152,567. PROPELLING APPARATUS FOR VESSELS. LAWRENCE YORK SPEAR, OF GROTON, CONN., ASSIGNOR TO ELECTRIC BOAT COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

Claim 1.—In a vessel, propelling apparatus comprising the combination of a propeller shaft, two internal combustion engines of different sizes, and means for mechanically connecting either of the two engines at will to the propeller shaft to drive the latter and thus propel the vessel whereby the vessel may be propelled at different speeds with the propeller engine operating at high efficiency. 5 claims.

1,129,934. PROPELLER. CARL THEODOR AUGUST HERMANN WIEDLING, OF NORTH BERGEN TOWNSHIP, HUDSON COUNTY, NEW JERSEY, ASSIGNOR TO THE WIEDLING MANUFACTURING COMPANY, OF NORTH BERGEN, N. J., A CORPORATION OF NEW JERSEY.

Claim 15.—In a rotary propeller, a hub and extending therefrom a plurality of blades of constant axial pitch both at the leading edge and the rear edge and so formed as to have driving faces of concave curvature in the co-axial cylindrical cross sectional lines thereof, the radii of curvature of which are multiples of the radial widths of the cross sectional water current areas pertaining to each blade section and the widths of the blades at the different radii of the propeller of which correspond to like multiples of the widths of the ideal blade of least width in which the radii of the cross sectional lines of the driving face are equal to the radial width of the cross sectional water current areas pertaining thereto and in which the axial pitch of both the leading edge and the edge of egress are the same as in the blades of multiple width. Fifteen claims.

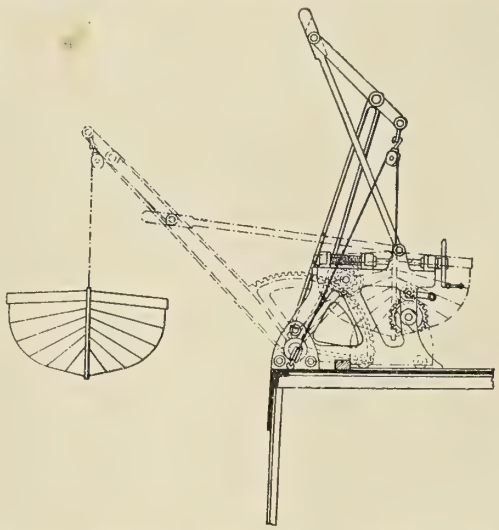
British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn place, W. C., London.

5,085/1914. IMPROVEMENTS IN SHIPS' HATCHWAYS. H. MORGAN, 26 HARROWBY ROAD, SEAFORTH, LANCASTER.

Relates to the closing of ships' hatchways, companionways, ventilators, etc., from underneath in an air-tight manner so as to prevent escape of air and thereby prevent the entrance of water into the ship through openings which might be made by collision, stranding, etc. It consists in attaching underneath the deck near to the lower part of the coaming of the hatchway a surrounding plate or ring having a faced under-surface or provided with a resilient packing. Underneath this ring are two plates with faced upper surfaces corresponding to the ring; these plates are supported on guides or slides, so that they can be moved towards each other to cover the whole area of the hatchway and bed against the surrounding ring, thus closing and making the hatchway air-tight. The plates may be moved rapidly by rack and pinions or any other suitable means.

148/15. MEANS FOR LAUNCHING LIFEBOATS. J. DE BEER, OF SPEELMANSTRAAT, 135A, ROTTERDAM, HOLLAND.

According to the invention, two rocking davits are used, each having at its upper end a double armed lever, one arm of which is connected by a pivoted rod to the frame and the other arm of which carries the launching tackle of the boat. When the davits are rocked outwards the



said rods compel the double armed levers to rotate, so that the same first assist in lifting the boat off its chocks, and then by swinging out assist in holding the suspended boat clear of the ship's side. It may provide the said levers with projections which, when the boat has been swung out, abut against the davits, so that the rods referred to assist in supporting the load and thus reduce the stress on the davits.

2,486/1915. AN AUTOMATIC GAS BUOY. A. P. COLLIER, 15 WHITEHALL ROAD, HARROW, MIDDLESEX.

Claim.—According to my invention the buoy and gas generator are so constructed that a separate removable container or cartridge supplied with the gas generating material and closed to entry of the water can be placed in position in the buoy while the latter is afloat and open to the water, and can then be opened to the entry of water for generation of the gas. A flotation chamber carrying the aforesaid removable container or cartridge is surrounded by an annular chamber through which the external water can pass into the bottom of the buoy, where it rises until it reaches the gas generating material through a suitable adjustable valve and grid or perforated bottom belonging to the container, any excess pressure of gas driving the water back so that a condition of equilibrium is soon attained and the gas is generated as it is required.

27,806/1913. IMPROVEMENTS IN APPARATUS FOR COALING SHIPS. J. SCOTT, 3 KNOWSLEY ROAD, BOOTLE, LANCASTER.

This invention relates to apparatus for coaling ships and is especially applicable to large ships, such as Atlantic liners, in which a comparatively large quantity of coal has to be taken aboard, either in dock or harbor or from barges through numerous coaling ports; the object is to provide power-driven apparatus carried from one of the supper decks, by which coal can be transferred from the barges to each of the several coaling ports simultaneously by means of a series of tipping buckets adapted to be hoisted by means of hoisting drums carried on two fore-and-aft power-operated sectional line shafts, one arranged on each side of the ship, the gear being wholly or in part of a portable character. There is one hoisting drum for each coaling port and the buckets in their elevated position are adapted to discharge into the coaling ports either by tipping over or by the release of shutters or doors formed in the bottom of the bucket.

INTERNATIONAL

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Why Shoot Mosquitoes?

IF a man were shooting in the heart of a fine game country it seems as though he would be foolish to start in to shoot mosquitoes and overlook the birds and other game.

A bill emanating from the Department of Commerce has been introduced in the House of Representatives requiring the numbering of small, undocumented vessels propelled by machinery. To properly enforce such a bill and its sister bill requiring the inspection of hulls and machinery and the licensing of the operating engineers on motor boats carrying twenty or more passengers would cost at least a million dollars (£205,000) a year.

Why shoot off such an immense amount of ammunition on such comparative trivialities when there is such urgent —we might safely say criminal—need for bringing up to date the laws pertaining to the inspection of steam vessels? If Congress plans to spend any money along these lines, let it be on shooting the big game. Let us have an inspection service such as the Inspector-General has been asking for for years. When this has been accomplished Congress can, in a fit of wanton extravagance, if it sees fit, put up the million dollars or more to let the Inspector-General shoot mosquitoes.

Ship Stability

ONE outcome of the recent *Eastland* disaster has been the introduction of a bill in Congress providing for the establishment of a board of naval architects in the office of the Supervising Inspector General of the United States Steamboat Inspection Service for the purpose of passing upon the plans of self-propelled vessels of 100 tons and over to be built in the United States for operation under the American flag. One of the main reasons for the establishing of this board is undoubtedly the expectation that such a board will serve to prevent another occurrence like the *Eastland* disaster, which was caused by the instability of the vessel.

That a thorough investigation of the question of the stability of ships is greatly needed is shown in the article on ship stability published elsewhere in this issue. As the author points out, although the expression "safe stability" is frequently used, it would be difficult to define it in exact terms. Neither the metacentric height, nor the angle through which a ship would roll without losing her righting moment, nor the maximum righting lever, would be of any value as a criterion of safe stability when taken separately. Even the knowledge of all three of these qualities is not sufficient to form an opinion as to a vessel's safety. Once the vessel is in service various circumstances affecting her loading and ballasting may alter her behavior within wide limits under various conditions of service and numerous examples are on record where experienced captains have been deceived as to the condition of their vessels with disastrous results. Theoretical conditions alone cannot determine the safe stability of a vessel, and it is only by combining theory and practice that a workable standard can be determined that will serve as a practical safeguard for all types of vessels and for all conditions of service.

To establish such a standard for safe stability would require an enormous amount of investigation of ships in commission, and it seems highly improbable that the proposed board of naval architects for the United States Steamboat Inspection Service would have the facilities or qualifications for carrying out such investigations or for doing more than is being done at present by competent classification societies. Such a project was begun in Germany just before the outbreak of the war and it was intended to establish a central bureau for collecting information on the stability of ships at sea, in addition to which calculations would be made so that the whole problem of stability might be placed on a proper basis. Such an investigation would be of inestimable value if carried out by the best qualified body of experienced and trained men obtainable, but the provisions of the proposed bill now being considered in Congress do not appear likely to attract men of such qualifications to this service.

Naval Experimental Laboratory

WHILE the recommendation made by the newly formed Naval Consulting Board for the establishment of a five-million-dollar research laboratory at tidewater for naval experimental work may seem to the general public like a radical innovation, as a matter of fact a laboratory of this kind, costing over half a million dollars and known as the Naval Engineering Experiment Station has been in operation at Annapolis for nearly eight years. The only reason why the work of this laboratory has not been conducted on the scale proposed by Mr. Edison and his associates for the new research laboratory has been the lack of appropriations for the work. If the sums recommended by the Naval Consulting Board for this work are provided by Congress, what better facilities could be offered than a further development of the present experiment station?

The experiment station is located on the Severn River, opposite the sea front of the Naval Academy. The grounds contain about ten acres and have a water frontage of about 1,600 feet. At present the laboratory is housed in a single building 316 feet long by 66 feet wide and an addition called the boiler house 66 feet by 34 feet and a boiler house extension 86 feet by 66 feet, with a 26-foot lean-to on three sides. The main building contains the offices, laboratories, storeroom, tool room, machine shop, wood-working shop, etc. The boiler house contains

a Niclausse boiler, a Babcock & Wilcox boiler, feed pumps, air compressors, condensers and a dynamo room with a 75 kilowatt turbo generator. The boiler house extension contains two airtight fireroom compartments, in one of which is installed an oil-burning Mosher boiler. The lean-tos around the boiler house contain a forge shop, an instrument storage and calibration room, a foundry, sheet metal shop and special testing devices. Some idea of the work done in this laboratory may be gained from the following: gage glasses have been thoroughly investigated, with the result that a type of gage glass employing mica to insulate the glass from the action of steam has been found which will give good service and a minimum of breakdown and attention. Packings and lubricating oils have been thoroughly investigated, with the result that the values of different types are better known and considerable savings have been made in the purchase of supplies of such materials. Corrosion of boiler materials has received a good deal of attention, both as to the materials themselves and as to the treatment of boiler waters, with the result that there has been developed a boiler compound which, when properly used, will prevent corrosion. This is known as the Navy Standard Compound, and is now being recognized and applied to engineering work in civil life. Photomicrography has been applied extensively in determining the proper causes of failures of metals. Tests have been made as to the relative efficiencies of coal stored under salt water. Boiler feed pumps, turbo blowers, water and oil metering devices, fuel oil burners, reducing valves, safety valves and various types of ordinary valves have been thoroughly investigated.

All tests are conducted from the service point of view and under conditions as nearly approaching conditions on board ship as the facilities of the experiment station will permit. Although the station has had little time for research work, the investigations into the merits of the appliances tested involved discussions leading to conclusions and recommendations which are worked out with a view to the probable improvements of the appliances. It is difficult to see how any other place that could be recommended would offer facilities so well suited to the purposes of a research laboratory as the site of the present experiment station. It is at tide-water within 500 feet of a 30-foot dredged channel and a waterway could easily be developed for the accommodation of battleships. It is located on one of the most strongly protected bays in the country, with a large, clear stretch of water for maneuvers, unhampered by shipping. It is adjacent to a large city and is within an hour's ride of the headquarters of the Navy Department. By developing the present facilities the research laboratory would be available at once.

Steamship Terminal Improvement

COMPETENT authorities agree that a saving of from 10 to 20 cents a ton can be saved in handling miscellaneous freight at marine terminals by the proper use of mechanical appliances. As government statistics show that over 300,000,000 tons of miscellaneous freight are handled at marine terminals in the United States every year, the possibilities of effecting great economies by the adoption of suitable mechanical appliances at the terminals are evident.

It is reasonable to assume that at least one-sixth of the total freight handled at marine terminals each day must be taken away from the terminals by street vehicles to destinations widely scattered within a radius of several miles. A case is cited elsewhere in this issue in which a steamship company increased the territory for collecting freight for transportation by its ships fourfold by using a motor truck service for the collecting of freight. In this case the commodity shipped was fruit which was grown on the shores of Lake Michigan. By adopting the motor truck service, fruit growers located twenty-five to thirty miles away from the steamship terminal were enabled to ship their products to Chicago economically by boat. The expense of this collection and delivery service was shared by both the fruit growers and the steamship company, and both benefited by it so greatly that it is probable that the service which was started as an experiment will be continued and extended in other places.

A similar case, cited in the same article, is that of a steamship line which operates freight steamers between Philadelphia and Wilmington on the Delaware River. This company maintains a collection and delivery service and recently has added motor trucks to its equipment for this purpose, thereby greatly increasing the economy and usefulness of the service. The practice of having the transportation companies handle the service of collecting and delivering the freight has long been established abroad, and has been tried in this country by at least one large railroad company, where it proved highly successful, but was discontinued because the Interstate Commerce Commission would not permit the absorption of the charges in the freight tariffs and a separate charge was found impracticable. There seems to be no reason, however, why some such arrangement could not be adopted with profit by certain of the steamship companies, and such a plan has been outlined in some detail by the secretary of the Electric Vehicle Association of America.

This association has given special consideration to the problem of eliminating congestion and the great waste associated with the handling of freight at marine and railroad terminals. The secretary of the Association goes so far as to predict that the time is coming when existing freight terminals will be eliminated, and instead of the present method of transfer of freight by miscellaneous concerns and individuals, the transportation companies themselves will deliver the freight direct to the consignee. It is expected that such an arrangement would work a great many reforms. In the first place, the loss of from $90,000,000 (£18,450,000) to $100,000,000 (£20,500,000) annually, chargeable to the delay in serving trucks at railway and marine terminals, would be eliminated by the operation of a fleet of electric stevedores on a scientific schedule, making relatively uniform demand for freight for the entire twenty-four hours. In cases where difficulty is experienced in obtaining additional pier accommodations, storage yards and warehouses, as is the case in many of our largest seaports, notably New York, a greater volume of freight could be handled in a less area than now utilized at the terminals, if the freight upon arrival at the terminals were properly handled and delivered. The adoption of electric stevedores would assure the delivery of the freight much more quickly than is the case with the existing system. Also night deliveries from the steamship terminals to the large establishments in the business districts of congested cities would greatly reduce the delays, as the freight could be delivered and the shipments handled when the streets of the city were not congested.

If the freight were to be distributed in the proposed scientific manner, the economies that would be effected in minimizing traffic losses, it is claimed, would be almost beyond reckoning. Not only could the vehicles be operated at night almost entirely uninterrupted at a relatively high rate of speed and at a lower cost per ton mile than it

they were constantly delayed by congested traffic, but the goods could be delivered much more rapidly and the freight which would be delivered in the day from well-located distribution points would suffer very much less delay than is now the case in endeavoring to transport freight long distances through almost impassable traffic.

This subject is one that undoubtedly deserves much more careful consideration from steamship officials than it has as yet apparently received. There can be no question but what a large amount of money can be saved not only by improved methods of collecting and distributing freight from marine terminals, but also by the proper use of mechanical appliances of various kinds for handling miscellaneous freight at the steamship piers. The latest types of coastwise and seagoing ships are well arranged for handling freight, so that there is little chance for much, if any, saving in the designing and equipping of these vessels. The great field, therefore, in which steamship owners can save more money is at their terminals by reducing the cost of handling the freight. During the past two or three years we have published a score or more of articles describing many installations of freight-handling appliances that have proved to be extremely useful to steamship owners. From the diversity of these various installations, there can be no doubt that almost any type of terminal arrangement can be greatly benefited by the proper use of these appliances.

Repair Costs of Motor Ships

OWING to the reluctance of owners and builders of motor ships to give out figures showing the costs of repairs to the machinery of this type of vessel, and the length of delays required for making such repairs, the belief has been quite general that the costs and delays due to repairs must be excessive as compared with similar costs and delays with steamships. This reluctance, however, has probably been due to the fact that, as motor ships are a comparatively new departure, owners and builders have felt that figures covering only a few months' operation would furnish no reliable criterion on which to base such data. But as time has gone on, and a considerable number of successful motor ships have been in continuous service for several years, data have accumulated which can be relied upon with some degree of certainty to represent true conditions in the operation of motor ships.

A case in point is that of the Royal Packet Company, which has four motor ships operating, together with a number of steamers, all of which carry passengers, mail and freight, principally the latter. Figures covering the costs of repairs and delays due to repairs on these vessels have been given in a report from the company's engineer-in-chief at Weltevreden, Batavia, Java, where the vessels operate. In this report it is stated that the motor ship *Sembilan,* of 300 tons deadweight capacity and 200 horsepower, has made ninety voyages in three years, with a total cost of repairs of about $2,400 (£492), very little time being required to make the repairs. The three other motor ships owned by this company are each of 1,750 tons deadweight capacity and 1,400 horsepower. One has made sixty voyages in twenty months, with a total cost for repairs of about $1,600 (£328). The other two sister-ships had only just entered the company's service when the report was given out, but had at that time required no repairs.

On the other hand, the total cost of repairs to one of the company's steamships of 1,400 horsepower was $1,000 (£205) for ninety voyages in twenty-two months, which is very nearly as much as that for the motor ship of the same power.

The fuel costs for the steamship, based on a coal consumption of 1.4 pounds per indicated horsepower, which is a fair average for a ship of this class and speed, amount to $117.67 (£24.1) for a daily run of 240 miles at sea. In the case of the sister Diesel motor ships, which are capable of carrying much more cargo, because of the less space required by the engines and bunkers, and also on account of the saving in weight of the machinery, a comparison can be made with the fuel consumption of the motor ship *Siberg* on her maiden voyage from England to the Dutch East Indies via Port Said. To the latter port the vessel averaged 9.9 miles per hour on 4.6 tons of oil fuel and 2.25 tons of coal for the auxiliaries. Therefore her total daily fuel bill—oil and coal—based on daily runs of 240 miles amounts to $45.62 (£9.35). In the sister ships of this vessel the donkey boilers are fired by the exhaust gases from the main engine, which makes a further reduction in the fuel costs.

Apart from the absence of stand-by charges in port, it is estimated that with the motor ships a saving of $21,594 (£4,430) on the fuel bill alone is realized in 300 days at sea. The total saving afforded by the motor ship, however, can only be appreciated when it is realized that several hundred tons more cargo can be carried and, with the present high freight rates, this is likely to mean an even greater gain than the saving on the fuel bill.

In the case of another motor-driven cargo vessel of 600 tons deadweight capacity and 250 indicated horsepower at 200 revolutions per minute, placed in service in 1910, the vessel had run a total of approximately 80,000 miles up to June, 1915. Repairs to the main engine during this time have averaged about $500 (£102.5) per year and $100 (£20.5) per year for the auxiliaries. The total time lost by the ship has been from three to four weeks per year, which included dry docking for scraping her bottom, painting, etc.

From the foregoing, therefore, it is evident that, while against the large savings in fuel costs and in additional freight carried in a motor ship there must be charged a slightly increased repair expense as compared with a steamship, also slightly higher wages to the engineer and the addition of several extra oilers in place of the stokers required on a steamship, nevertheless the question of repair costs should be no deterent to the successful operation of motor ships. Due to the present market conditions, motor-driven ships will show to great advantage for the Atlantic trade. The best steam coal is now quoted at Cardiff and Newcastle at from $4.50 (18/9) to $6 (1/0/10) per ton, and is not likely to become lower for many years. In fact, it is extremely unlikely that it will ever get back to its old figures, because the wages of the miners cannot be expected to drop back to the comparatively low figures of a year ago. On the other hand, a motor ship can obtain oil fuel in America and carry sufficient in her bunkers for the voyage to Europe and back and still carry several hundred tons more cargo than a coal or oil-fired steamer of the same displacement could carry with bunker capacity for one voyage. These facts are fully realized by European shipowners, and to-day there are 35 Diesel engine-driven merchant ships on order, 96 percent of which will be equipped with either Burmeister & Wain or Werkspoor engines. The Western Australian Steamship Company recently paid $101 (£20.7) per ton for the new motor ship *Lalandia* of 6,700 tons deadweight capacity, a record price for a tramp ship, yet a net profit of over $125,000 (£25,600) a year is expected from this ship even after all expenses and depreciation have been paid.

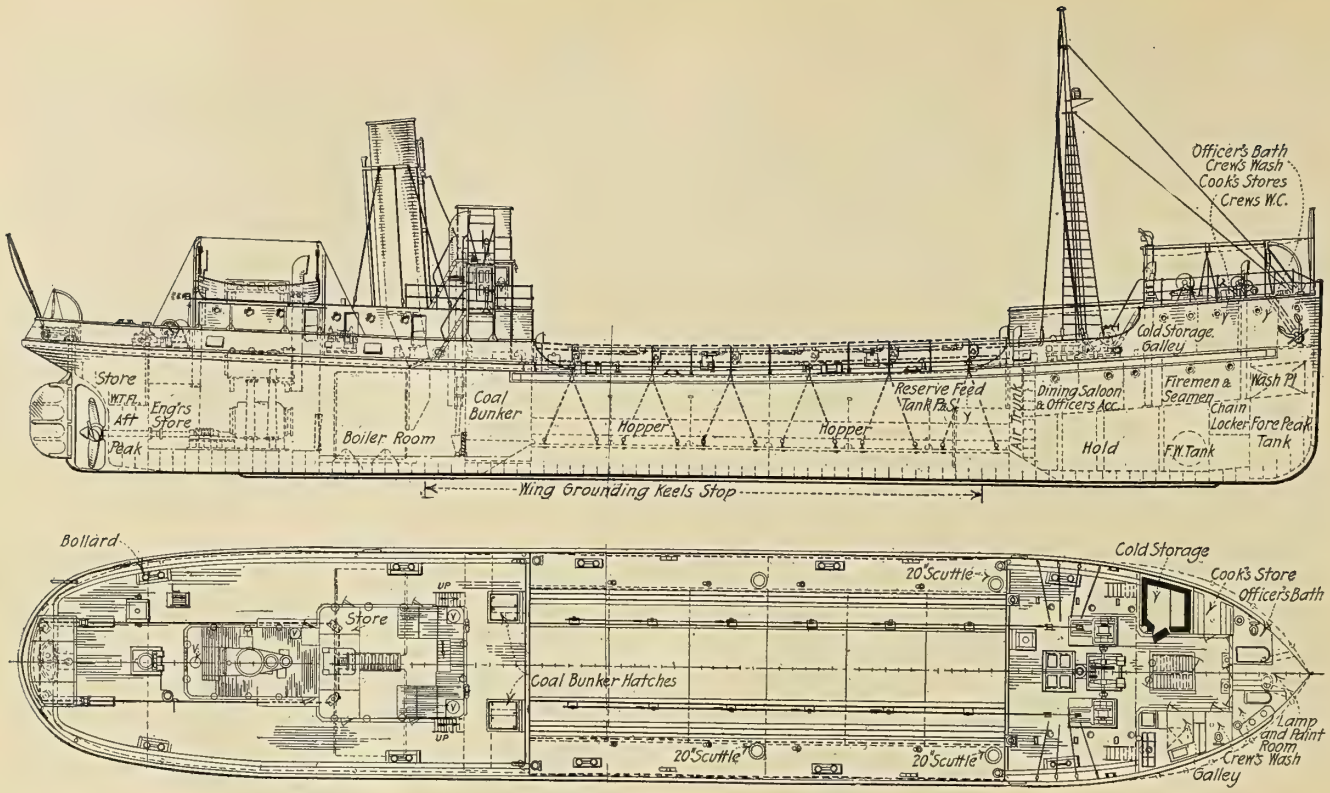


Fig. 1.—Profile and Deck Plan of Canadian Government Hopper Barge No. 2

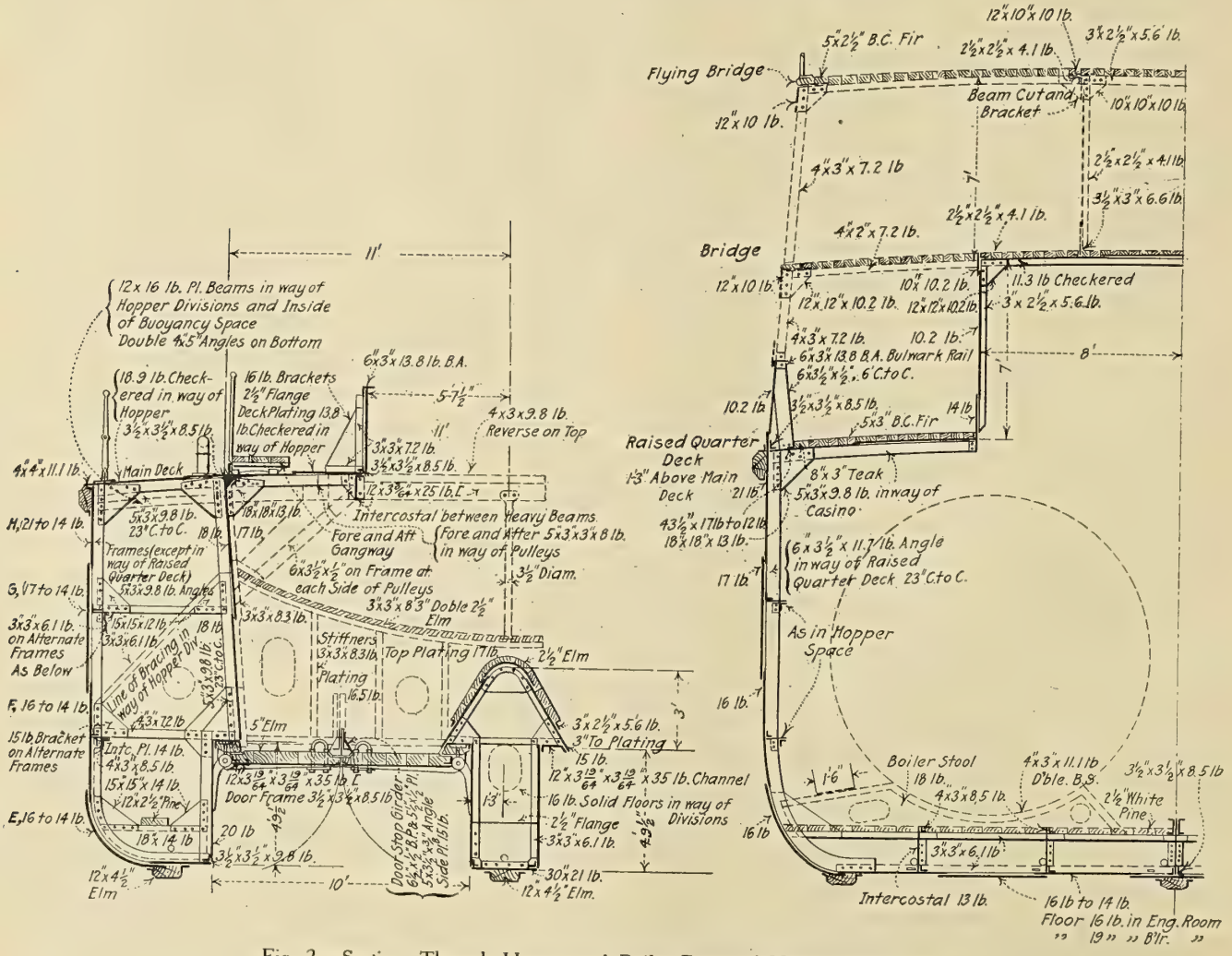


Fig. 2.—Sections Through Hopper and Boiler Room of Hopper Barge No. 2

Canadian Government Hopper Barge No 2

Self-Propelled Hopper Barge Built by the Collingwood Shipbuilding Company for Government Work on the St. Lawrence River

A hopper barge of 530 cubic yards capacity, designed for work on the lower St. Lawrence River, where she will take away spoil from both the bucket and suction dredges, was recently completed by the Collingwood Shipbuilding Company, Collingwood, Ont., for the Dominion Government. The vessel is built of steel throughout to Lloyd's highest class, and is of the following dimensions:

Length overall	187 feet.
Length between perpendiculars	180 feet.
Breadth, molded	32 feet.
Depth, molded to main deck	14 feet 6 inches.
Depth aft to bottom of grounding keels	13 feet.

The hopper space, which contains 530 cubic yards, is divided up as shown on the accompanying plans. There are six sections of the hopper in all, and each section is



Fig. 3.—Hopper Barge No. 2

provided with two doors constructed as shown on the midship section.

These are secured by very heavy cast steel strap hinges and are lowered and raised by means of 1¼-inch bridal chains, having heart-shaped shackles at the upper end to take up any movement. A chain leads up through the deck casting and over a sheave and is attached to a strong draw-bar running the full length of the hopper coaming. Two threefold purchase blocks are fitted at the fore end and a wire rope is led from these on to the drum of a powerful winch situated at the after end of the forecastle.

The port or starboard doors can be raised or lowered independently, and any set of doors can be raised or lowered without interfering with the other. When the doors are hove up they are set up by heavy cotters at the deck casting. The doors are made of rock elm and the hopper keelson is lined with similar material.

As will be seen from the midship section, the doors are recessed well into the hull to enable the vessel to be put ashore at any convenient place and the doors lowered for repairs without projecting beyond the bottom of the ship.

Accommodation for a crew of fourteen is provided in a 'tween-deck forward, the rooms being spacious, well lighted and ventilated.

The machinery consists of a set of compound surface-condensing engines made by the builders, having cylinders 20 inches and 40 inches by 27 inches stroke, and designed to develop 700 indicated horsepower at 120 revolutions, and 125 pounds steam-pressure. The boilers, two in number, constructed by the builders, are of the regular Scotch type, 12 feet 3 inches diameter by 10 feet 6 inches long, working under natural draft.

A very complete set of auxiliaries is installed, including Weir's feed pump, Gwynnes' circulating pump, feed heaters, filters, etc., and everything has been arranged so the vessel can work in either salt or fresh water. A very complete installation of electric light has been provided, and sanitary and heating arrangements are provided suitable for a vessel of this class.

Trials were run on the measured mile at Owen Sound on September 8, when a mean speed of 8¼ knots was obtained, and, on a six-hours' trial, 750 horsepower was developed with the vessel loaded with spoil to a mean draft of 13 feet. Trials of the dumping gear were carried out later, and the gear worked smoothly. Mr. Charles F. M. Duguid, naval constructor of the Department of Marine and Fisheries, witnessed the trials on behalf of the Dominion Government, the builders being represented by Mr. John S. Leitch, manager of the company.

The vessel sailed for Quebec on September 11.

Shallow Draft Boats and Barges for River Navigation*

BY COL. L. H. BEACH AND LIEUT.-COL. CHAS. KELLAR

The advance which has been made in the size, machinery and power of ocean-going vessels within the past fifty or sixty years has been almost marvelous. Vessels have increased from a gross tonnage of 2,860 tons in 1850 to 43,500 tons in 1910. Allowable boiler-pressure has increased from 25 pounds in 1857 to 200 or 300 pounds at this day. The length of vessels has steadily increased from 282 feet to 500 and 600 feet for freight-carrying vessels and 850 feet for passenger and quick-freight traffic. No advance worthy of the term has, however, been made in river craft, which follow the same method of construction and practically the same methods of propulsion as were in vogue fifty years ago. The only improvement made is the allowable boiler-pressure.

To see whether developments could not be made which would be commercially economical and correspondingly advantageous to the community, the Congress of the United States recently directed the design and construction of "two experimental towboats of modern but different types with a complement of suitable barges and necessary loading and unloading facilities for towing and delivering supplies along the Mississippi River and its tributaries." A board of engineer officers was appointed to make the necessary investigations and carry out the work involved. It found nothing in print or otherwise of record in available form connected with its task, and has had to investigate the entire field practically from the beginning. It has made thousands of tests concerning the best forms for barges and the most economical methods of grouping in tows, and finds that while the form of barge giving best results is to a certain extent dependent upon the duty which is to be performed—that is, whether it will be used for a long or short haul, whether towed always singly or in combination with others in a tow—there are

* Abstract of paper read before Engineering Section of Second Pan-American Scientific Congress, Washington, D. C., January 3.

two or three forms which give best results, and that other shapes should be excluded if the greatest efficiency is desired. One result of their work is to decide the question which had been greatly debated by coal producers in the upper Ohio and its tributaries as to whether economical results could be secured by using sets of nestable barges, the small barges to be towed up stream empty within the larger barges. The board's results enabled a definite answer to be given to this problem.

The board further conducted a most extensive series of experiments concerning paddle wheels upon which nothing definite had previously been determined and concerning which no experiments had been scientifically conducted. Some of the facts developed by the board's experiments are as follows:

A feathering wheel has practically the same power as a radial wheel of twice the diameter.

The thrust increases with the immersion when width of blade and number is constant.

The thrust increases with the increase in number of floats within usual limits, and varies approximately directly as the length of float.

No additional thrust is gained by separating the wheel into two parts. Thrust varies approximately as diameter for constant immersion.

The efficiency decreases rapidly toward the higher values of slip and also with increase of immersion.

The thrust and efficiency of a feathering wheel vary with the position of the feathering eccentric, the thrust generally decreasing with the increase of eccentricity.

The Floating Hospital Helen C. Juilliard

New Vessel Built from Designs by Tams, Lemoine & Crane for St. John's Guild, New York

The new floating hospital for the St. John's Guild, New York, to replace the *Helen C. Juilliard,* long known in New York harbor, and to be called by the same name, will be a great improvement over the old ship, which has done such good work for so many years.

The new boat has been built from Messrs. Tams, Lemoine & Crane's designs and under their supervision by the American Car and Foundry Company, Jackson & Sharp plant, Wilmington, Del. Her length on deck is 230 feet 8 inches, breadth outside the planking of 45 feet, and draft aft 10 feet.

She is of wooden construction, all materials going into her being most carefully selected. In this connection it may be stated that the architect's inspector—Mr. J. J. Driscoll—was the supervising inspector of the old ship.

Her keel is of white oak and measures 12 inches by 14 inches. The stem is of white oak, fastened to the keel with hook scarphs. The apron is of white oak, as are also the stern and rudder posts, the deadwoods being of yellow pine.

The frames are of white oak and chestnut, double sawn, spaced 24 inches apart. The upper part of the frames extends clear up to the hurricane deck. The floors are of oak, sided 5 inches, and the keelsons are of yellow pine, of which there are seven, running the full length of the vessel for strengthening fore and aft.

In addition, there are two bulkheads running fore and aft, of yellow pine, on top of which are set the hog frames. Stringers and clamps are also of the same, and the knees are hackmatack. The deck planking is of yellow pine.

The principal details of the hull construction and the main scantlings are shown in the midship section, Fig. 1.

The deck plans show the arrangement of the ship, which has been very carefully thought out. The dining room has tables seating four hundred people. There is a waiting room, examination room and operating room, which in every detail will be up to date. There is also a large ice box, a sterilizing room, four distinct wards, and on the hurricane deck is an isolation house.

Fresh-water tanks of 15,000 gallons capacity are fitted, in addition to salt-water tanks of 10,000 gallons capacity, permitting patients having clear salt baths at all times. In all shower, bath and toilet rooms monolithic floors are laid, all sanitary details of this sort being of first importance.

The fire-fighting system has been most carefully worked out, and consists of fire pumps of large capacity with outlets serving all parts of the ship. For supplies there are

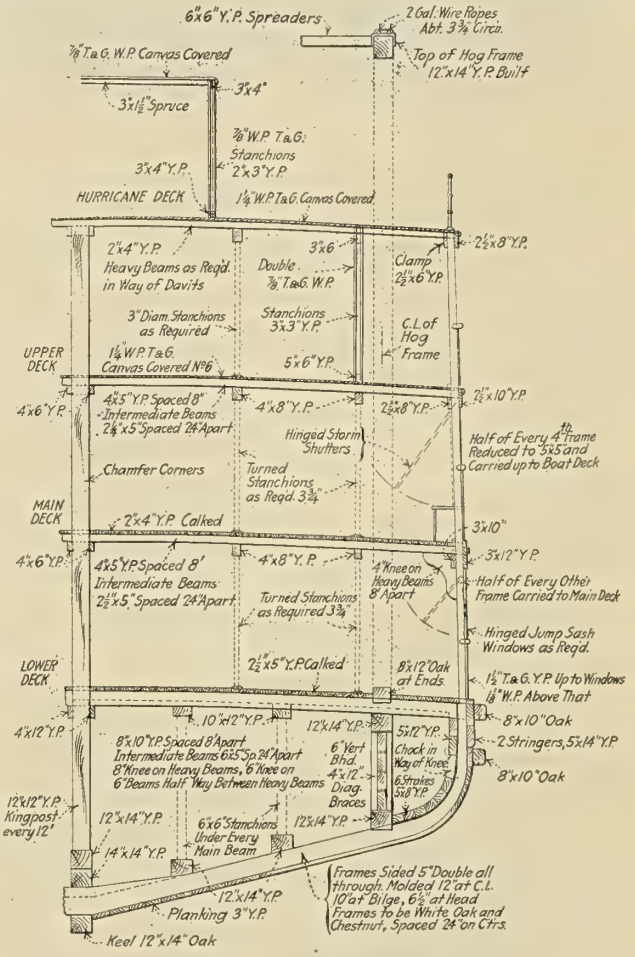


Fig. 1.—Midship Section

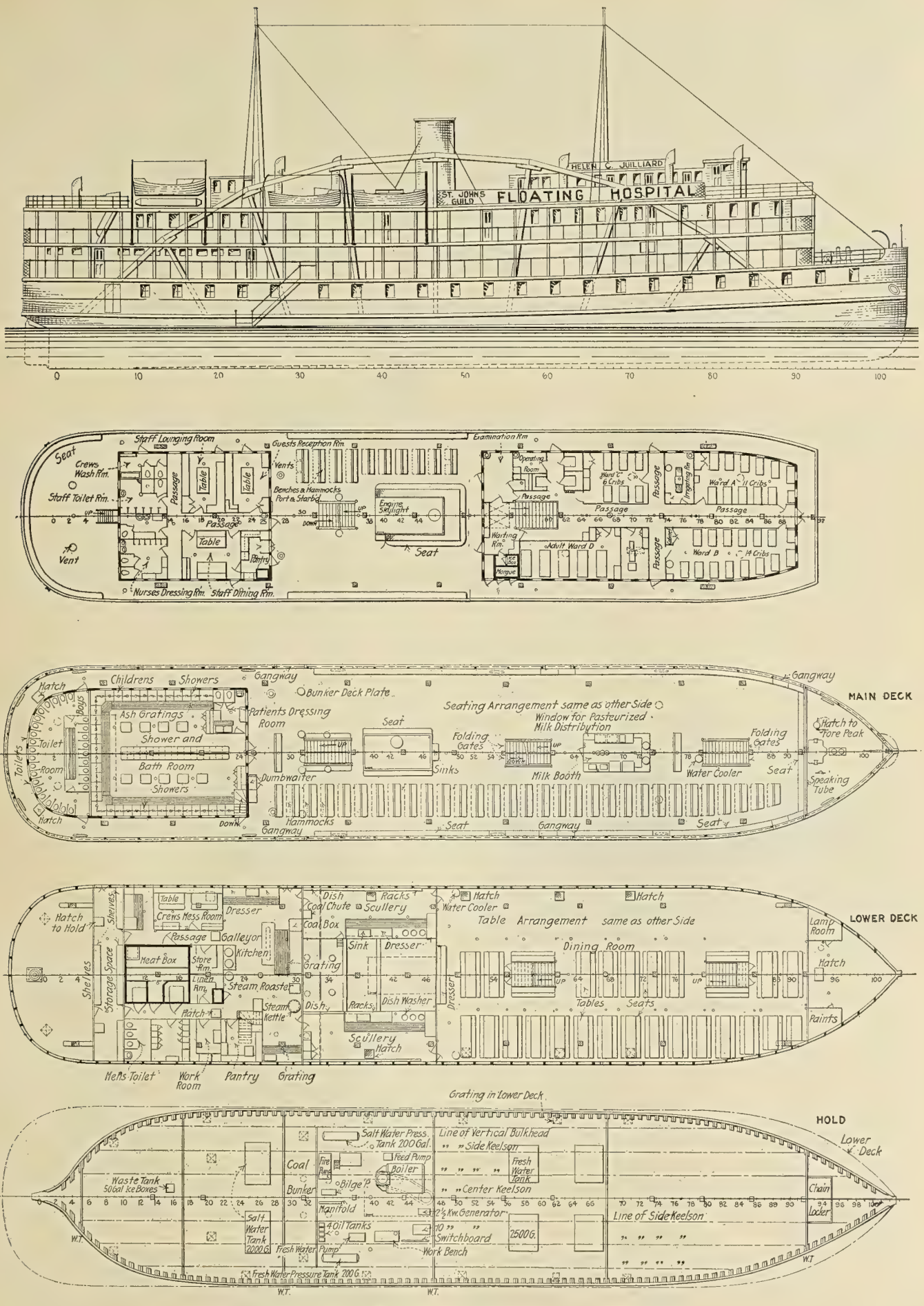


Fig. 2.—General Arrangement of Floating Hospital *Helen C. Juilliard*

large refrigerating rooms, with separate meat rooms, vegetable and dairy rooms, the latter being particularly large to accommodate the large supply of milk necessary.

A Scotch boiler 7 feet in diameter and 9 feet long is installed for running all the auxiliaries, the electrical equipment being most complete, including two of the latest type generators for supplying, in addition to the lighting system, current for operating fans, motors and thermostatic pads for use in the wards. The boat itself will not be self-propelled, but towed, as in the case of the former ship.

The life-saving equipment includes four 18-foot and two 20-foot life boats, also an 18-foot yawl, life rafts, life preservers, etc. All this equipment is based on the capacity of sixteen hundred.

There are living accommodations for doctors, nurses, attendants and crew, with separate dining and sitting rooms.

New Tugs for Central Railroad of N. J.

Extensive Experience in Harbor Lighterage Service and Towing Leads to New Features and Improvements in Design of New Tugs

BY ALTON A. NORTON

Two new tugs have recently been built for the Central Railroad of New Jersey which embody new features and improvements which have been brought about through experience with former tugs in the service of the same company.

One, the *Bethlehem,* was built by the Staten Island Shipbuilding Company, of Port Richmond, N. Y., for the lighterage service. It was deemed advisable to use a high-pressure engine on account of the muddy rivers and creeks they are compelled to navigate. The engine is 22 inches by 28 inches, and steam is supplied at 150 pounds gage-



Fig. 1.—The *Bethlehem*

pressure by a three-furnace Scotch boiler 14 feet 6 inches diameter. Principal dimensions of the *Bethlehem* are as follows:

Length on deck	98 feet 0 inches
Beam, molded	24 feet 0 inches
Depth, molded	12 feet 7 inches
Draft, loaded	11 feet 0 inches
Displacement	about 320 tons

Except in size, the general arrangement of the two tugs is practically the same. The other tug, the *Newark,* was built at Elizabethport, N. J., by John W. Sullivan, and the machinery installed at the Ninth street yard of the same company.

The following is a general description of the *Newark,* which is being used in the car-float service of the company:

General Dimensions

Length overall	110 feet 0 inches
Length between perpendiculars	97 feet 9 inches
Beam, molded	26 feet 0 inches
Depth, molded	14 feet 6½ inches

Hull Particulars

The hull is of steel, built exceptionally strong. In the design care has been taken to make the interior accessible for efficient scraping and painting. As will be seen in the accompanying profile, her forefoot and deadwood

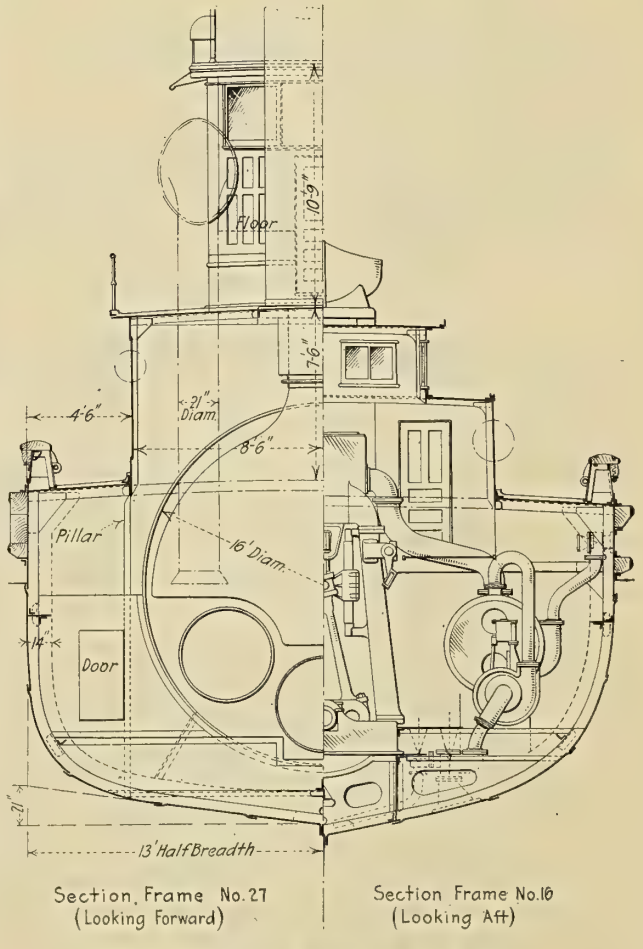


Fig. 2.—Midship Section of the *Newark*

aft have been cut away to a coniderable extent. This enables the tug to turn in a circle of shorter radius. A balanced rudder of the side-plate type is fitted.

Reverse frames follow the top of floor plates only and are continuous athwartships. They are doubled in way of the engine room.

A deep keelson extending from the collision bulkhead to the after-end of the engine room is fitted. Longitudinal strength is further assisted by side keelsons and stringers, the side stringer being deep and formed of intercostal plates and clips, between frames, with a continuous angle along the outside of the frames. This gives great stiffening power to plating below the lower fender rail, where it is very frequently needed.

The bulwark construction is clearly shown in the section. The bulwark aft has been set in, and three heavy cast steel protecting chocks are fitted. This arrangement was adopted to minimize the chances of breaking the bulwarks at this point.

The space between the first and second fender guards is filled in with solid wood from the stem to amidships, the object being to reduce the damage to the hanging fenders caused by the localized bearing of the fender guards on them.

A cross coal bunker is fitted between the engine and boiler room, with a coaling trunk extending down from the upper deck. This is a very convenient method, as the tug can take on her full fuel capacity without having to turn around at short intervals on account of excessive list, as encountered in filling side bunkers. Two ash bunkers are also fitted in the after corners of the fire room. A passageway between the boiler and engine rooms is cut through the cross coal bunker. Boiler feed water is supplied from two built-in fresh-water tanks, the forward one having a watertight flat forming the top with the frames bracketed to this.

There are four watertight bulkheads placed as shown in the profile. The deck is of steel, covered with "Litosilo."

Deck House

The deck house has been very conveniently arranged, as will be seen from the deck plan. The archway cut through the house is a novelty and has proven to be very handy in the working of the tug. It affords quick access from one side to the other, also a temporary shelter for the deck crew. Lines are conveniently stowed in the archway, where they dry quickly and are immediately accessible. Entrances to the engine room are fitted through the after part of the archway, the working platform of which is lowered below the main deck.

The primary purpose of lowering and narrowing the after part of the deck house was to obtain an unobstructed view of the stern from the pilot house. To further this purpose the smokestack and ventilators were made elliptical in section. It has been found that this form of engine room gives better light, better ventilation and also a better view from the handling platform. The deck house is constructed of steel and the pilot house of wood.

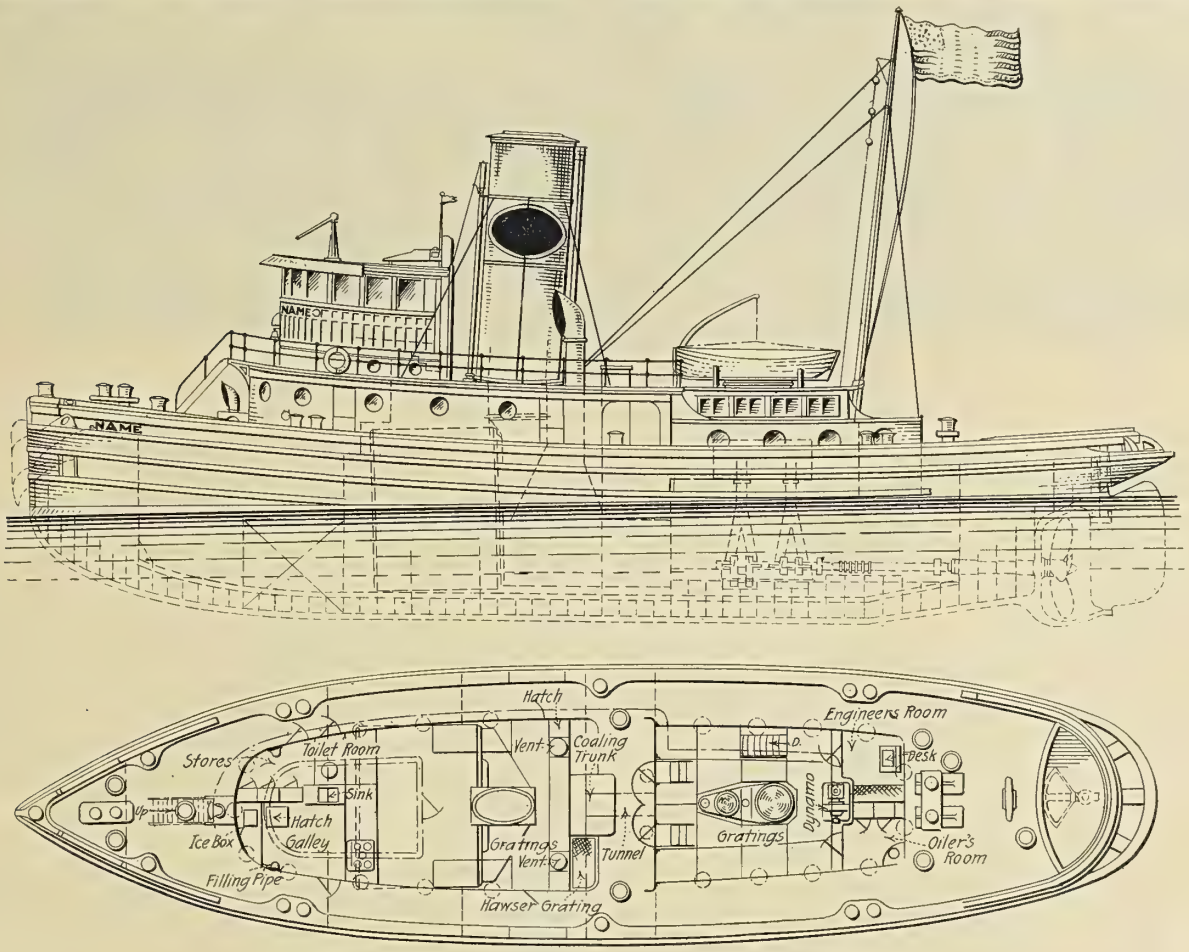


Fig. 3.—General Arrangement of the *Newark*

Machinery

The propelling machinery consists of one fore and aft compound engine, one cylindrical return tube boiler, a surface condenser with centrifugal circulating pump, independent air, feed, bilge, fire and sanitary pumps, feedwater heater, electric lighting plant with direct-connected engine.



Fig. 1.—Bunkering a Steamship at New Southern Railway Coaling Pier

The cylinders of the main engine are 19 inches and 40 inches diameter by 30 inches stroke. High-pressure valve is a semi-plug piston type, and the low-pressure cylinder is fitted with a double-ported slide valve. The valves are operated by Stephenson link-valve gear.

The feed-water heater is of the multicoil type, the exhaust from all auxiliary machinery being run into it to supply the necessary heat.

The air pump is a vertical twin-beam, single-acting pump; the feed and bilge pumps are of the vertical, simplex type, and the fire pump of the horizontal duplex type.

The boiler is 16 feet inside diameter by 12 feet 3 inches long over the bottom heads, with a working-pressure of 175 pounds per square inch. The three suspension furnaces are connected to a common combustion chamber. The boiler is also fitted with a modern form of circulator.

The steering gear is of the ram type as manufactured by the Staten Island Shipbuilding Company.

The tugs are an excellent example of the progress made in the marine departments of the various railroads, due to their use of one particular type of boat. By close observation of previous tugs in service and careful recording of data, new tugs are designed that embody the good features and eliminate some of the difficulties of former tugs.

The specifications require many parts to be constructed in accordance with Central Railroad of New Jersey standards, designs which are the result of experience in former boats.

The hull and general arrangement were gotten out by Mr. W. S. Macdonald, marine inspector of the Central Railroad of New Jersey, and the machinery equipment by Mr. William Riechman, the chief engineer of the marine department.

LIGHTSHIP LAUNCHED.—Lightship *No.* 101, under construction at the works of the Pusey & Jones Company, Wilmington, Del., was launched on January 12.

SALE OF DANISH VESSELS PROHIBITED.—The Danish Government has forbidden the transfer of Danish vessels to foreign ownership.

Southern Railway Coaling Pier at Charleston, S. C.

The first modern coaling pier on the Atlantic seaboard south of Norfolk has recently been completed by the Southern Railway at Charleston, S. C., at a cost of $500,000 (£102,500), although the plans provide for the ultimate development of the plant to four times its present capacity. The present plan consists of a steel pier 375 feet long, a 3,065-foot approach trestle, a 370-foot tail track and a 2,250-foot trestle for the return-empty track. On the pier is a movable coal-loading tower with a hopper of 200 tons capacity into which cars can be dumped at the rate of one every two minutes, and from which the coal is transferred to the vessels at the pier by a link

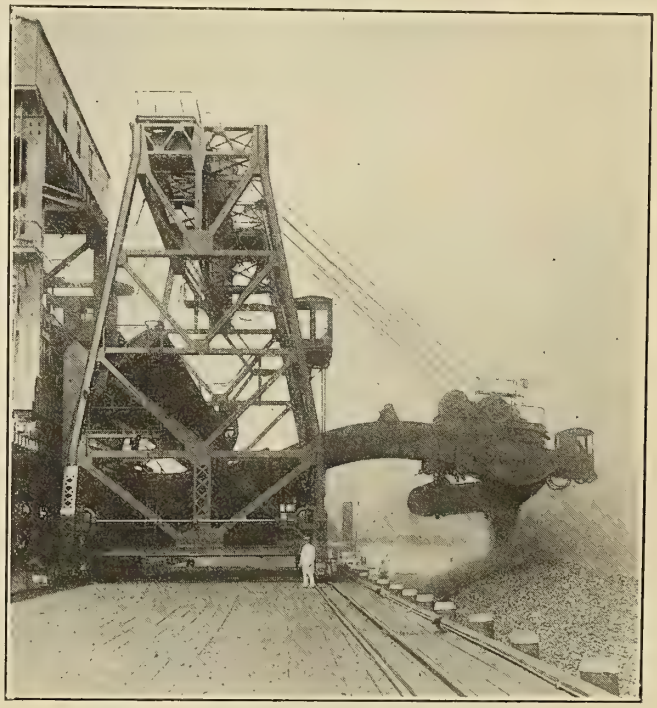


Fig. 2.—Coal-Loading Tower in Operation

belt conveyor operating in a movable boom which can be adjusted in accordance with the position of the coaling hatches on the vessel. The cars are pushed onto the car dumper by switch engines, and after they are dumped they pass down a 2½ percent grade to a kick back that gives them the necessary momentum to carry them down a 1 percent grade on the empty return track.

The car dumper and loading tower, including all machinery and structural steel, were furnished by the Wellman, Seaver, Morgan Company, Cleveland, Ohio. The steel framework of the car dumper extends 56 feet 9 inches above the top of the approach trestle and the dumping cradle is operated by two 150-horsepower electric motors arranged in parallel located at the top of the structure. The cradle is moved along the trestle track by a 100-horsepower motor, all of the operations being controlled from a central station.

The loading tower, which is at a level 17 feet 2 inches below that of the car dumper, carries a hopper with fixed sides and back, but with a movable bottom or pan pivoted at the lower end. Normally this pan is on a slope of about 45 degrees, permitting it to be emptied by gravity, but when it is desired to shift the tower independent of the dumper, the pan can be put in a horizontal position, doubling its capacity from 100 to 200 tons. The coal is taken from the hopper by a belt conveyor, operating in a curved boom having a maximum reach of 30 feet 11 inches beyond the pier. The end of the boom is equipped with a telescopic chute which may be swung in an athwartships direction, and at the end of which is a trimmer cowl which swivels on a vertical axis, thus giving extreme flexibility for placing the coal in the vessel and reducing hand trimming to a minimum. All movements of the loading tower and boom are actuated by electric motors controlled from two stations.

Bulk Cargo Steamer Chokyu Maru

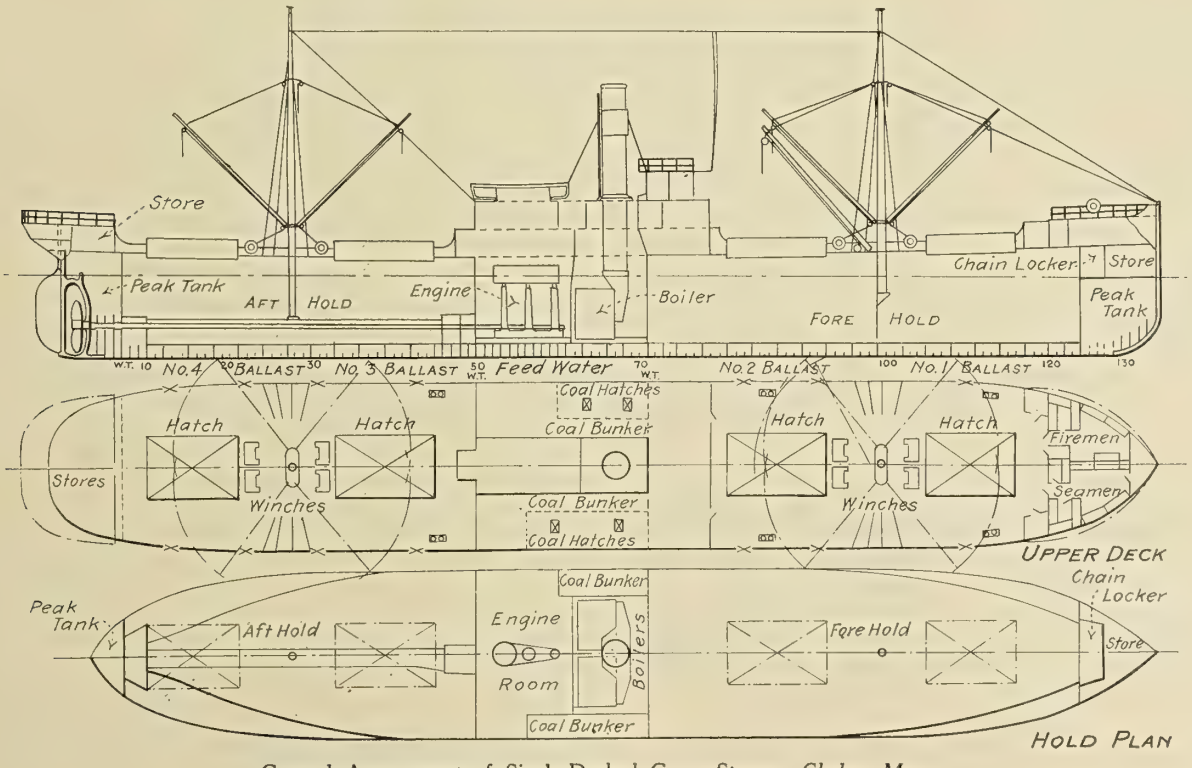
Description of New Japanese Cargo Steamer Built by the Uraga Dock Company—Launching and Trial Data

BY T. RYU

The single-decked cargo steamer *Chokyu Maru* was recently completed by the Uraga Dock Company, Japan, for the Kamaishi Steel Works, to transport iron ore and coal between Formosa and Japan. The principal dimensions of the vessel are as follows:

Length overall	277 feet 7 inches
Length between perpendiculars	268 feet
Breadth molded	40 feet 9 inches
Depth molded	23 feet 6 inches
Draft, loaded	19 feet 9¼ inches
Displacement	4,887 tons
Carrying capacity	3,067 tons
Speed	11 knots
Indicated horsepower	1,060

As shown in the general arrangement plans, the lengths of the deck erections are shortened so as to afford longer



General Arrangement of Single-Decked Cargo Steamer *Chokyu Maru*

hatchways, making the forecastle 27 feet, the bridge 63 feet and the poop 23 feet long. No. 1 and No. 4 hatches are 22 feet by 15 feet and No. 2 and No. 3 hatches 24 feet by 15 feet, so that the length and width of the hatch openings is 34 percent of ship's length and 37 percent of ship's breadth respectively.

Two 4-ton winches, with 7-inch cylinders and 12-inch stroke, are provided for each hatch, while a 15-ton derrick at No. 2 hatch serves to handle heavier loads. The height of the hatch coamings is 3 feet, and they are stiffened with bulb angles.

Hollow cylindrical pillars are adopted in place of extra strong hold pillars, in order to lessen the wear of wire ropes in cargo handling. No ordinary ladders are provided for in the hatchways, but they are fitted inside the masts so as to give clear space in the holds. Hold stringers are dispensed with by using thicker outside plating.

Taking coal as cargo at 45 cubic feet per ton of 2,240 pounds, the capacity of the fore hold is 1,806 tons and of the aft hold 1,261 tons. The side coal bunkers contain 124 tons and the reserve bunker in the bridge contains 218 tons, making a total of 342 tons.

A skeleton floor system is adopted for the inner bottom plating, extending from bilge to bilge. The capacities of the peak tanks and the double bottoms are arranged so as to avoid excessive trim at light draft, and to have about one foot trim without ballast at load draft. The capacities of Nos. 1, 2, 3 and 4 water ballast tanks, and the fore and after peak tanks are 79.2, 94.7 and 112.8 tons of water respectively. Under the engine room 45 tons feed water is carried.

The construction of the hull adopted has reduced the weight of steel required by about 3 percent as compared with ordinary methods of construction. The weight of the vessel is 1,370.3 tons, consisting of 1,155.8 tons for the hull and 214.5 tons for the machinery, including the water in the boiler.

Launching Data

Declivity of keel blocks	1/17
Declivity of launching ways	1/16
Length of sliding ways	217 feet
Width of sliding ways	1 foot 9 inches
Width of standing ways	2 feet
Center to center of sliding ways	14 feet 6 inches
Average pressure on standing ways	1.35 tons
Maximum pressure on the fore poppet when the stern lifts	315 tons
Height of water at the end of standing way,	5 feet 6 inches
Launching speed	16.2 feet per minute
Launching weight, including cradles	1,033 tons
Average draft when afloat	4 feet 7⅛ inches
Displacement when afloat	971 tons
Center of gravity of the hull and cradles,	0.83 foot aft of amidships

Machinery

Propulsion is by a triple expansion engine with cylinders 19 inches, 31½ inches and 52 inches diameter by 39 inches stroke, operating at 75 revolutions per minute. The cooling surface of the condenser is 1,207.5 square feet. Steam is generated by two Scotch boilers 12 feet 6 inches diameter by 10 feet 4 inches long at a working pressure of 180 pounds. The propeller is 14 feet diameter, 4-bladed, with 17 feet 3¾ inches pitch.

Trial Data

Weather	Windy and rain
Average draft	9 feet 7¾ inches
Trim	5 feet 7 inches
Displacement	2,199 tons
Midship area	374.8 square feet
Average speed	11.02 knots
Indicated horsepower	1,161.6
Slip of propeller	17.3 percent
$\frac{D^{2/3}\,V^3}{\text{I. H. P.}}$	196.79
$\frac{V^3}{\text{I. H. P.}}$	436.16
$\frac{\text{I. H. P.}}{\text{I. H. P.}}$	0.318
$\frac{\text{H. S.}}{\text{I. H. P.}}$	10.95
G. A.	
Coal consumption (Australian coal),	3.1 pounds per horsepower hour

Harbor and Port Terminal Facilities and Work*

BY H. MC L. HARDING†

To create a satisfactory interchange of commerce between the States of the Pan-American Union it is necessary not only that there be a large merchant marine for the carriage of goods and commodities between ports, but that there should be such harbor terminal facilities and works as will secure the greatest speed and economy in cargo transference (loading and unloading) between vessels and shore, and in the handling (assorting, distributing and tiering) upon the shore, not only equal to but superior to any harbor works and equipment in the world.

The paper treats of the following subjects: Influence of terminal costs, commercial supremacy, terminal facilities, ships' detention, rapidity of transference due to terminal design, similarities in port designs, relation of terminal expense to carriage expense, typical terminal design, rail and water coördination, congestion points, quay terminals, transit shed, warehouse, no railway cars in dray shed, types of mechanical appliances, railway connections, industrial and commerce terminals, comprehensive plan in the beginning, terminal elements, freight movements, terminal units, size of units, the substructure (quay walls), fresh-water quay terminals, relieving platform, teredo-infested waters, the superstructures, shed capacity, railroads, mechanical appliances, terminal designing.

Conclusions

First.—For all the ports of the Americas, and especially for those concerned with Pan-American commerce, those harbor works, terminal facilities, operating methods, and mechanical appliances should be adopted which have proved most efficient in respect to time and economy of cargo transference and handling.

Second.—That all new terminals for inland and ocean navigation should be so designed, planned and proportioned in respect to the piers, quays, sheds, warehouses and railway tracks as to secure easy, quick and economical inter-coördination between all these terminal elements and with the water carriers.

Third.—That not only should the world's best be adopted and then adapted to the operating conditions of

* Abstract of paper read before Engineering Section of Second Pan-American Scientific Congress, Washington, D. C., January 4.

† Consulting Engineer, New York.

each country, but terminal engineers should continually study to achieve something better.

Fourth.—That the securing of the greatest speed possible in all marine freight terminal movements is of all terminal features that which is the most essential for reducing the cost of transporting freight.

Cooperation Between Motor Trucks and Steamship Lines in Handling Freight*

Territory for Collecting Freight Increased Four Times by Motor Truck Service—Greater Shipments of Fruit to Chicago by Boat

BY H. L. WHITTEMORE†

Over 300,000,000 tons of freight are annually hauled to and from marine terminals alone, a total of more than 600,000,000 tons handled, or 1,800,000 tons every working day. With but little exception, the entire movement of railroad and steamship freight has to be handled by some highway carrier. This fact alone establishes a working relationship between motor trucks and the common carriers.

The piers and railway freight terminals of our big centers in many cases present a problem that not only militates very strongly against the motor truck, but creates a condition that makes it impractical for the motor truck to step in and even point a possible way to solve that problem. The congestion at these terminals is so bad that motor-truck owners are loath to send their trucks there. A motor truck under most conditions is far more economical than horse-driven equipment, but a motor truck, like any other vehicle, is only making money when it is under way with a paying load, and where conditions hold it idle for a long time the interest charges on its first cost cut into its earning capacity at a rapid rate.

Congestion at New York Piers

In New York City the congestion at the piers and freight stations is terrific, and I cannot help feeling, after studying the conditions there, that the steamship and railroad lines have only begun to take the possible steps for relieving these conditions. An instance where conditions have been very materially improved is on the piers of the Fall River Line, where freight is handled on the pier by mechanical freight handlers. Before this system was installed it was necessary for all trucks either bringing freight to the line or taking it away to go on the pier. Now no trucks delivering to the line go on the pier, but simply back into the bulkhead and deposit their loads, which are handled from there by the mechanical handlers. On an average day 300 trucks deliver freight to the Fall River Line and 200 collect freight from them. Before the old system was abolished each of the 500 trucks had to work on the pier; now the same space is reserved for 200. As a result of this, shippers dealing largely with the Fall River Line find that motor trucks are paying better than where they are working at some other terminals.

It is not at all infrequent for trucks to have to wait from three to four hours every working day in the year. With motor trucks this delay causes an actual loss of from $200 to $480 (41/13/4 to 100/0/0) per vehicle per year. As methods to overcome this delay are adopted, more and more motor trucks will be used.

Looking at this question from the other side, let us see whether the increased use of motor trucks cannot affect a substantial saving in dollars and cents for the companies operating the freight terminals. The more congested the space the more the rental of the terminal costs—on the west side of New York the rental of pier space is something over 80 cents (3/4) per square foot per year. A single horse delivery wagon is about 18 feet long and occupies about 90 square feet, while a small motor vehicle of similar capacity occupies scarcely more than 10½ feet in length, or 60 square feet, a saving of at least 25 percent when an extra space for maneuvering is allowed The average saving per year of a motor truck in this one respect would be about $16.00 (3/6/8), as about the same difference exists between the two-horse team and the larger motor as betwen the smaller units. It is estimated that about 40,000 vehicles are constantly engaged in trucking to piers on the west side of New York—if only half of these were replaced by motor vehicles the annual saving to pier owners of this one district in increased space available for storage would be close to $300,000 (£61,500) a year.

An interesting case of the application of motor trucks to steamship terminal problems is the service rendered during the past summer by the Fruit Belt Auto Truck Express to the fruit growers of the fruit belt around Lake Michigan. I am particularly interested in this work because I happened to be in Chicago last June when our Chicago office sold the first trucks to this company. While this operation was only carried on during a part of last season, it has already demonstrated its practicability and has served as a beacon that lights the way to a use for motor trucks that it is impossible to see a limit to.

How Fruit Growers Benefit by Motor Truck Line

Of necessity a boat is handicapped by lack of mobility, and steamship lines have had to draw their freight business from industrial and agricultural communities within a short distance of navigable waters. An active-minded man who lived in South Haven, Mich., saw the advantages both to the steamship line and to the fruit growers if he could extend the territory from which it was economically practical to ship fruit to Chicago by boat. This man inaugurated the Fruit Belt Auto Truck Express, and, as he renders a real service to the steamship company and to the farmer, he collects from both of them. The farmer pays him a certain amount per barrel or bushel for transporting fruit to the boat, and the steamship company pays a percentage of the freight rate for the new business created for them.

During the summer of 1914 the Chicago and South Haven Steamship Company carried about 500,000 pieces

* Extracts from a paper on "The Place of the Motor Truck in General Transportation," read before the Rivers and Harbors Congress, Washington, D. C., 1915.

† With the Autocar Company, Ardmore, Pa.

of fruit freight, a very considerable item of business. All of this freight came from farmers living within a radius of 15 miles of South Haven, most of it from those within 8 or 10 miles of the lake. The motor trucks easily reach farms 25 to 30 miles away and really extend the possible territory about four times. Although I have not the actual figures of increase, I have a letter from the steamship company assuring us that any steps we might take to increase the service during the coming season would meet with their heartiest coöperation.

It is easy to see in this case how motor-truck service is a distinct advantage to the farmer and to the steamship line. The farmer is saved the inconvenience of hauling to a terminal, and in addition to that has his fruit carried to Chicago in a few hours in the cool of night, so that the fruit reaches the market in better condition. Moreover, the produce gets to Chicago much earlier in the morning and arrives at a point much nearer to the commission houses to which it is consigned. The shipments are sorted on the dock according to the consignees and a bulk receipt taken for all the fruit destined for each consignee, which greatly facilitates delivery.

Advantages of Motor Truck Service

From the point of view of the steamship company this system has two very decided advantages. It opens up new business that they previously were unable to get and it reduces the overhead expenses of handling business, as the consignments come to them in bulk instead of in smaller quantities from each individual shipper.

The most conclusive evidence that this sales plan has all the elements of a permanent success is the expression from the farmers themselves. The Chicago and South Haven Steamship Company have forwarded to us several letters from fruit growers that testify to their appreciation of the service rendered. A. L. Stewart, whose address is Route 1, Box 50, South Haven, writes: "The Autocar trucks running on the main roads and leading to the steamboats which run between South Haven and Chicago are so great an advantage to the farmers that every effort should be made to promote their use. Several fruit growers have signed their names to the following letter: 'We wish to thank you for the service the Autocar trucks have rendered the farmers this summer, and trust they will be with us another year. It has been discouraging to them doubtless many times on account of the roads being in such condition, but we expect that the townships will improve them before another season, at which time we hope to see the trucks again.'"

The following is another case that has interested me particularly:

The Bush Line, of Wilmington, Del., runs freight steamers between Philadelphia and Wilmington. While this line has always maintained a collection and delivery service, it is only within the past few months that they have added motor trucks to their equipment. In talking to Mr. Bush the other day he said that the Autocars had not been working long enough to have set up actual figures of cost and profit, but, he said: "We are selling nothing more or less than service, and we have had a great many expressions of appreciation of the improved service that our motor trucks are rendering." Here is a case where Autocars are proving their efficiency on short-haul work, for, although none of the hauls is over three miles, the trucks are averaging 35 to 40 miles a day, as against 12 to 15 miles for a two-horse team.

In one sense, these trucks are working under ideal conditions, for they are owned and operated by the company that owns the piers, and every possible step is taken to make them as efficient as possible. The space of one side of the wharf is given to the trucks, and the freight is assorted with that in mind.

The business houses that are served by Autocars are saved a great deal of time, as the trucks cover a route in less than half the time that horses take. The Bush Line finds that on the item of overtime labor alone the Autocars are effecting a big saving. The trucks get to the pier in the evenings from a half to three-quarters of an hour earlier than the horse-drawn wagons, which means a great deal, as overtime is paid for all dock work after 6 o'clock.

There is no doubt but that the motor truck is a time-saver, and by that very reason alone it is a logical and sound step in the evolution of transportation.

Ship Stability—The Need for Investigation

BY A. T. WALL *

In spite of all the work that has been done in connection with the stability of ships, very little attempt is made to apply the results practically. It is true that in most shipyards nowadays the stability of a vessel is investigated in the design stages, but that in itself, useful and necessary as it is, is not sufficient.

Whatever precautions the designer may take, he can only allow for certain contingencies. After leaving the builder's hands a ship will be loaded up in a great many different ways, and it is impossible to predict all these conditions. Nearly every loading must be considered individually if anything like a true idea is to be formed of the stability of the vessel. In cases where similar, or nearly similar, cargoes are constantly carried it would be sufficient to determine the condition once, but in the majority of cases the load in a ship varies with every voyage.

At present the legal responsibility for the safety of a ship rests with the captain. Much legislation has been passed recently in regard to the building and running of merchant vessels, but neither the new laws nor the old ones, with one exception, make any mention of safe stability. The exception referred to has reference to the stability of passenger steamers. The British Board of Trade stipulates that the stability of any passenger steamer should be sufficient to render the vessel safe. It sometimes happens that the Board steps in and insists upon some additional stability being given to a ship by some means or another before granting the passenger certificate. No definition has ever been advanced by the Board of Trade as to what they consider to be sufficient stability, and in any case, as the stability they consider necessary can only take account of the ship in a general and not in a particular way, it amounts to the same thing as a good designer does for the ship, and the same criticism applies.

That accidents do happen to vessels through lack of stability needs no proof; numerous cases are on record where the facts have been established, and other instances come to mind in regard to vessels lost at sea without leaving any trace. Although the expression "safe stability" is used, it would be difficult to define it in exact terms. Metacentric height by itself is no criterion; a value which would make one ship safe might easily be dangerous for another vessel. Range of stability; that is, the angle through which a ship would roll (provided no water was shipped) without losing her righting moment, is equally no criterion when taken alone. Neither is the

* Naval architect, Messrs. Cammell, Laird & Co., Birkenhead.

maximum righting lever any more valuable. Even a knowledge of all these three quantities is not sufficient to form an opinion as to a vessel's safety. Absolute size of the ship, as well as the area of top hamper exposed to the wind, are factors which play important parts. Theoretical considerations alone cannot determine safe stability. In this matter, perhaps more than in any other, practice and theory must be combined. It is not suggested that naval architects do not know how all these qualities should be combined in a ship to make her quite safe, but it will generally be found that different experts would give different combinations for the same ship, in accordance with the dictates of their experience. This simply means that there is no standard for safe stability, and to set one up an enormous amount of careful investigation on ships in commission would have to be carried out.

At present ships go to sea without any exact knowledge of their stability conditions being available; in consequence, it is impossible to form any useful comparisons for future guidance. When a new ship is ready to sail some very elementary particulars of her stability may be given to the captain, often in such form as to be quite useless to him. They will generally be put away carefully and hardly referred to again. The captain then proceeds to form his own idea of his ship's stability. The vessel will sail on her first voyage, except in a few cases, with too ample stability, as the captain naturally does not wish to run any risks. From her behavior on the maiden voyage the captain forms his conclusions for future guidance, and ever afterwards the stability is practically fixed by rule of thumb.

Fortunately, the stability of a ship can vary within very wide limits without serious results. Too much stability is not good for a vessel; it unduly strains the structure and makes the ship uncomfortable in a seaway. If this excess of stability is obtained by the use of water ballast, then needless weight is carried about with the ship. On the other hand, if the stability is too small, the danger is too obvious to need detailed comment.

While rule-of-thumb methods are adopted to decide the stability of ships, many disadvantages will result, and sometimes with serious consequences. Numerous examples can be given showing how even an experienced captain may be deceived in regard to the condition of his vessel. Many of these come to light, but a far greater number probably go unrecorded. In one instance a ship was thought to be tender when loading, and water ballast was put in at the expense of cargo. At sea the vessel was found to be quite stiff, and the extra water ballast that had been taken in was pumped overboard, the ship still being amply stable. In another case a ship was behaving badly at sea, and more ballast was taken in, with the intention of rectifying the defect. This proceeding in itself was dangerous, but fortunately nothing serious happened. Actually, however, the ship became worse, and later it was found that her initial bad behavior was due to the fact that she was already too stiff. Perhaps a somewhat glaring instance of wrong procedure occurred with a small ship putting into a port on the East Coast some few years ago. The vessel had a list, and one lifeboat on the high side was filled with water, with the intention of remedying it. The ship then listed to that side; the opposite lifeboat was now filled with water, and shortly afterwards the vessel turned turtle. Quite recently the Dutch seagoing motor boat *Zeearend* was taking in general cargo at Rotterdam, and when the deck load was almost complete the vessel capsized. The capsizing of the *Eastland* is still fresh in memory, and illustrates a remarkable case of incompetency and ignorance on the part of those responsible for the safety of the ship. It was common knowledge that the vessel was tender and that water ballast had to be used to render her safe for the carriage of passengers. In spite of this, the ballast was omitted with results that are well known.

Such happenngs as these, and many more like them, would be next to impossible if some systematic efforts were made to provide those responsible with reliable information wherewith they could assess the stability of their vessels. It cannot be said that mercantile captains are not capable of appreciating the points involved, for in some cases—especially among the larger lines of passenger steamships—the captains are given information and know how to use it, and the results of their experiences are placed on record for use in future designs.

Quite apart from the disadvantages that arise from the lack of knowledge of the stability of a vessel, there are many advantages accruing from possession of all the facts. In the first place, no superfluous ballast need be carried about, giving a direct saving in coal consumption. At other times, with a ship nearly loaded down to her Plimsoll marks, it becomes necessary to decide whether ballast should be taken in to ensure sufficient stability, or if the remaining weight may be used for additional cargo. As often as not—from ignorance of the true position—the ballast is taken, although a little investigation might show the vessel to be amply safe. In entering shallow waters it is not uncommon for the captain to trim his vessel on to a level keel to avoid excessive draft aft. In such cases definite knowledge of the minimum water ballast required from stability considerations would considerably assist him. Again, in making a journey from one port to another it would often be useful to the captain if he knew exactly how much water ballast should be added to compensate for the consumption of coal, fresh water, etc., as the ship proceeded on her voyage.

It is sometimes argued that there is no time to make suitable inquiries into the stability of a ship when she is loading up hurriedly at a port, as time is money, but the expense involved by so doing would generally be far more than compensated for by the reduced amount of water ballast carried, as well as, in some cases, by the extra cargo that could be taken. When a ship is running light the circumstances are entirely changed. Water ballast, and as much of it as possible, must then be carried to increase the draft of water and give her a "grip" in the water, as well as to provide good propeller immersion.

As has already been remarked, a large amount of labor would be involved in setting up some definite standard of stability. Before the war it had been decided in Germany that a central bureau should be set up for the purpose of collecting information on the behavior of ships at sea, in addition to which calculations would be made so that the whole problem of stability might be placed on a proper basis.

A few contributions have been made to technical societies on the subject. In 1913 two papers were read before the Schiffbauteschnische Gesellschaft, one by Herr Ludwig Benjamin and the other by Dr. Carl Commentz. The former considered that minimum values should be fixed for the righting levers at two angles of inclination of the ship, while the latter urged the necessity for careful investigation of stability with the object of recommending minimum stability curves for different ships. A year later a paper was contributed to the Institution of Naval Architects by the writer, giving a method for the comparison of stability between different ships or the same ships under different conditions of loading.

These papers, however, only touch the fringe of the

subject. Joint action on a large scale is necessary if results of any value are to be obtained. It is not sufficient to confine attention to a ship in still water; rolling in a seaway, wind pressures, virtual loss of weight of the ship in the trough of a sea, shifting of weights and shipping of water are some of the things that must be allowed for. The behavior of ships at sea whose stability conditions are well known needs to be carefully noted, and when good results have been obtained they can be used as a working basis. Incidentally, the stability of ships when damaged could be given attention—a study in itself.

The present-day knowledge of stability is quite sufficient to ensure that no vessel need put to sea with any uncertainty as to the sufficiency of her stability. The dangers arise from lack of application of the known results. The responsibility for safe loading should not, on any account, be taken from the captain, but he could be enormously assisted in carrying out his duties in this direction if the necessary steps were taken. In the larger field of what might be termed the determination of minimum safe stability there can be no doubt, in view of the resulting advantages, that the matter will sooner or later be taken up in earnest, with far-reaching results for the benefit of shipowners and seafaring men.

United States Naval Experimental Wind Tunnel at Washington Navy Yard

Description of the Largest Wind Tunnel in the World—Wind Speeds up to 75 Miles an Hour Available for Experiments

BY NAVAL CONSTRUCTOR WILLIAM M'ENTEE, U. S. N.

The large experimental wind tunnel which the Navy Department has established in the Washington Navy Yard at the Experimental Model Basin, where warship models are tested, has now been in operation about a year. The tunnel is the largest in the world, having a section 8 feet square at the point where the models are placed for testing. In addition to the advantage gained by the size, it is possible with the 500-horsepower, motor-driven fan to get wind speeds up to 75 miles an hour, which permit experiments being made at real flying speeds.

The tunnel consists of a closed circuit shaped like the link of a chain, as shown in Fig. 1. The 500-horsepower top horizontal discharge fan of the corrugated paddle type, with an inlet diameter of 11 feet 2 inches, and a discharge duct 7 feet 6 inches by 9 feet, is placed at one end of the link. At the other end, where the air straightens

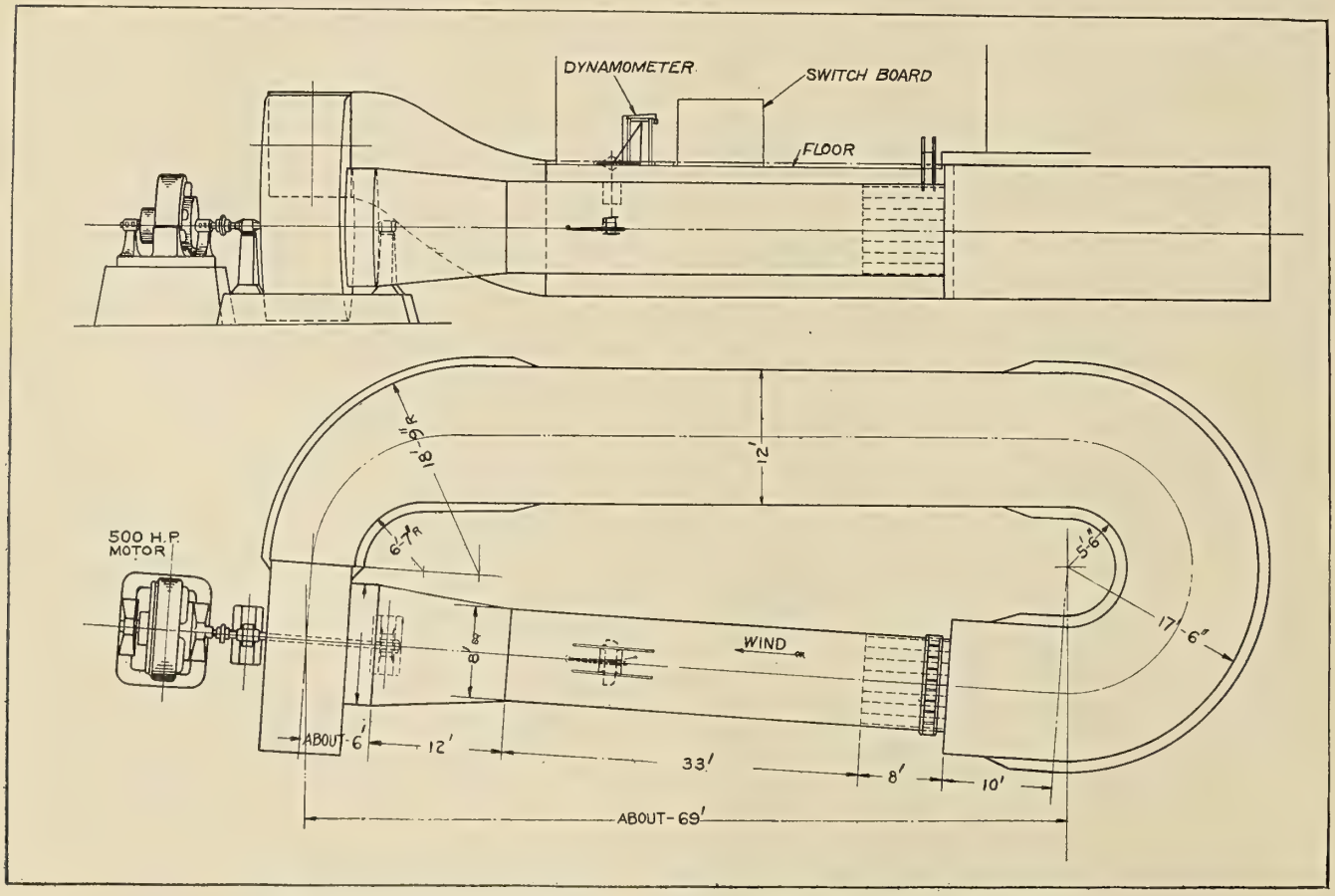


Fig. 1.—Diagram Showing General Arrangement of Naval Experimental Wind Tunnel

out before flowing through the experimental chamber, are the baffles, which are necessary to remove the eddies and to control the uniformity of the speed. These baffles consist of 64 cells, each 1 foot square and 8 feet long. Each cell is provided with its own damper, so that the velocity of the air in any one section may be controlled. At the experimental chamber in the vicinity where aeroplane wings or models are tested the maximum variation from uniform flow is about 2 percent.

The tunnel is built of wood, with frames spaced about 3 feet on centers placed outside and sheathed on the inside, with 7/8-inch tongued and grooved sheathing laid in two thicknesses in the direction of the air current, and with building paper placed between the two layers. The necessary curvature is obtained by bending the sheathing, the whole of which is blind nailed.

The fan is driven by a 250-volt, 500-horsepower, direct-current motor, arranged for operation on the Ward-Leonard system. The motor also has auxiliary field control, so that any desired speed up to about 200 revolutions per minute, which corresponds to a wind speed of 75 miles an hour, may be obtained. At the discharge side of the fan are located 12 pitot tubes which lead to an integrating manometer which gives the average velocity of discharge. This velocity has been calibrated against the velocity obtained at the section in the experimental chamber, where the aeroplane or other model is placed, so that any desired velocity may be obtained at that point with precision without having any pitot tubes or obstructions other than the model being tested. In other words, by calibration the velocity of discharge may be found, and this bears a certain constant ratio to the velocity at the experimental section.

The velocities were determined by pitot tubes which were checked with those used in the Aerodynamical Laboratory of the Massachusetts Institute of Technology, and in the National Physical Laboratory in England.

Among recent investigations of interest made at the wind tunnel was the determination of the coefficient of air friction for various aeroplane and balloon fabrics. Tests have been made on the new dirigible building for the Navy Department, and on models of naval aeroplanes both building and projected. A number of tests have also been made for private concerns. In carrying out experiments for private parties, the same practice is followed as in the case of tests of ship models; that is, the actual cost of doing the work is charged in each case. On account of the large size of the tunnel it is possible to test comparatively large models of aeroplanes with widths up to 36 inches.

Fig. 2 is a photograph showing the arrangement of the model of an aeroplane when being tested. The model is carried by a steel spindle which extends up through the top of the tunnel to the weighing balance, which is placed overhead. For about two-thirds of the length of the tunnel the spindle is covered by a mask of stream line form. This mask is secured to the ceiling of the tunnel and reduces the force acting on the spindle itself, and thus the spindle correction. The weighing balance consists of a weighing scale on the platform principle having three axes, two of them at the same horizontal line 61 inches apart, and the third vertically over one of the first, 48 inches above it. When a model is set at a given angle, the moments acting about each of these axes are measured by weighing them on the scale. With these data it is possible to compute horizontal and vertical components of the force acting on the model; that is, the drift and lift, and also to compute the line of application of the force. Tests are usually made at speeds of 40 miles an hour. At this speed and at the angle of least resistance an ordinary aeroplane

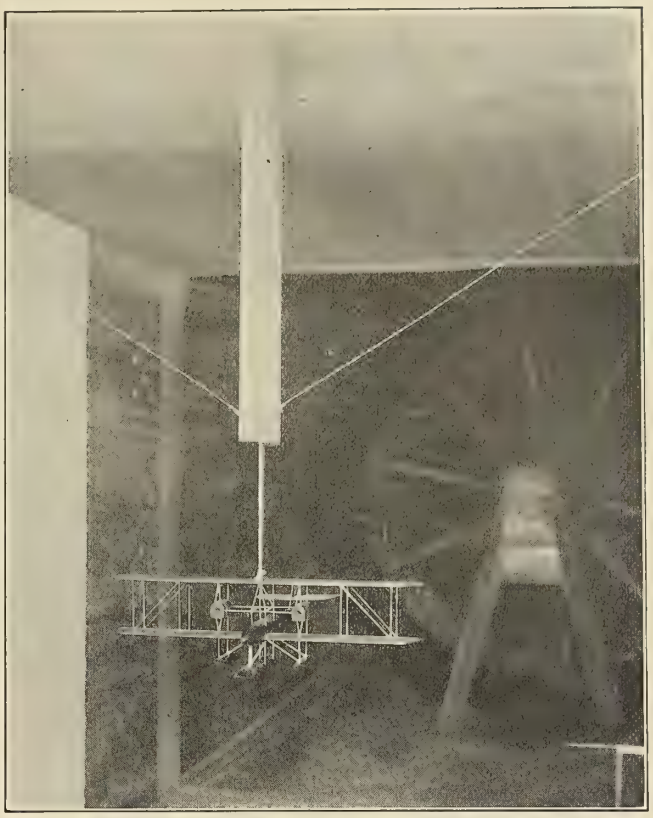


Fig. 2.—Testing an Aeroplane Model

wing model has a horizontal resistance of something less than one-tenth of a pound. It is therefore necessary that the balance should be capable of weighing a force with accuracy to about 2/1,000ths of a pound.

The large size of the tunnel makes it possible to test full-size radiators for aeroplane motors, and comparative tests have recently been made on several types both as to air resistance and cooling capacity.

The wind tunnel has also been used for certain other tests which are not directly connected with aeronautics, such, for example, as the determination of the influence of form and dimensions on the size of ventilating cowls for use on ships. These tests have shown that it is not necessary to exceed certain dimensions which are less than have heretofore been used in many cases. It is proposed shortly to obtain the wind resistance of a large battleship, this being an element of a ship's resistance which has not previously been accurately measured.

In conjunction with the wind tunnel, the model basin is used for determining the best form of floats for hydroplanes, and there will no doubt be many other cases where the data derived from tests made in the water may be applied directly to aeroplane design.

Vessels Built in United States.—The Bureau of Navigation, Department of Commerce, reports 32 sailing, steam, gas and unrigged vessels of 20,307 gross tons built in the United States and officially numbered during December, 1915. The largest steel steamers included in these figures are: *Floridian,* of 6,930 gross tons, built by the Maryland Steel Company, Sparrows Point, Md., and owned by the American-Hawaiian Steamship Company; the *Munamar,* of 3,477 tons, for the Munson Line, also built by the Maryland Steel Company; and the *Bylayl,* of 3,289 tons, built by the New York Shipbuilding Company, Camden, N. J., and owned by the Pocahontas Navigation Company.

Propeller Design for Turbine-Driven Ships

Methods of Determining the Principal Dimensions of Three-Bladed, High Tension, Bronze Propellers for Turbine-Driven Vessels

BY N. A. GRAVESON *

The propellers for turbine-driven vessels, owing to the high number of revolutions at which they run, have brought forward a different design of propeller to that generally used on reciprocating driven vessels. The latter follow more or less the elliptical form advocated by the late Dr. Froude—i. e., long blade and relatively narrow width of blade, but the turbine-driven propeller running at a high speed and having to obtain a large blade surface, so that the pressure per square inch on the blade surface can be kept between certain limits, assumes a disk-like and sometimes a pear-shaped form of blade. The ratio of projected blade surface to the disk area of the propeller advocated by Dr. Froude was .2 to .26, and in later years destroyer propellers rose to about .35, while turbine-driven propellers can be said to start at .4 and rise to .8, the latter figure being for light, fast vessels.

The principal dimensions of propellers depend upon the following:

$S.\ H.\ P.$ = shaft horsepower developed in the shaft and delivered to the screw.
$E.\ T.\ P.$ = effective thrust power = $S.\ H.\ P.$ × suitable factor.
V = the speed of the ship in knots.
S = apparent slip of the screw.
T_r = total resistance of the ship.
R = revolutions of the screw per minute.
U = speed of the wake in knots.

And also upon the type and shape of the vessel, especially the stern.

Revolutions

The revolutions of turbine-driven propellers range through the following: 200 and 300 revolutions per minute for large vessels with full lines, to 800 revolutions per minute for fast, fine-lined vessels.

Apparent Slip

The apparent slip is the following:

$$\text{Apparent slip} = \frac{\text{speed of screw} - \text{speed of ship}}{\text{speed of screw}}$$

all being in the same units. The apparent slip depends upon the revolutions, the speed and shape of the vessel, the blade surface, and the diameter of the propeller.

In dealing with the apparent slip mention may be made of the actual slip. The propeller works in the wake stream of the vessel, and this stream of water follows the forward motion of the vessel, being greatest in ships with full stern lines. The actual slip is given by the following:

$$\text{Actual slip} = \frac{\text{speed of screw} - (\text{speed of ship} - \text{speed of wake})}{\text{speed of screw}}$$

In practice it is usual to work off the apparent slip, as the actual slip can only be arrived at when the velocity of the wake is known—and it is difficult to arrive at this.

The apparent slip of turbine-driven screws, between 200 and 800 revolutions per minute, is given by the following empirical formula:

Let R = revolutions per minute of screw and S = apparent slip.
Then $S = .0206\ R + 12$.

There will be deviations from the slip given by the above, owing to tides, etc., but it will be found to hold good for general purposes.

Diameter

To get the diameter of a propeller, it is necessary to be able to deduce the effective thrust. This is a long and tedious process to do theoretically and involves such a large number of factors that the practical man has not the time to spare, and it is, therefore, best to use an empirical method which has given good results in practice.

This consists of employing suitable coefficients to suit various types of vessels, and this method was advocated by Mr. Speakman in a paper before the Institution of Engineers and Shipbuilders in Scotland. C, the coefficient, depends upon the pressure per square inch on the blade surface and the ratio of the projected blade surface to the disk area of the propeller, and is applied as follows:

$$C = \frac{\sqrt{\text{effective thrust in pounds}}}{\text{diameter of propeller in feet}}$$

The effective thrust is the power required to propel the vessel and is equal to the shaft horsepower multiplied by a coefficient varying from .55 to .52.

The effective thrust in pounds is given by the following formula:

$$E.\ T. = \frac{S.\ H.\ P. \text{ on one shaft} \times 33{,}000 \times .52 \text{ or } .55}{\text{speed of vessel in knots} \times 101.3}$$

The table below gives the value of C and ratio of E. T. P. to S. H. P. for various vessels:

Type of Vessel	Speed of Vessel	Approximate Revolutions of Turbines	E.T.P. / S.H.P.	Apparent Slip, Percent	C
Large ocean mail steamer	24 to 25	190 to 200	.53	16.5	23
Intermediate ocean mail steamer	21 to 23	330	.55	18.8	24.6
Cross channel steamers	24	500 to 550	.53	20.5	25
Fine-lined fast vessel	28	750	.52	27.5	30

For vessels coming in between the above types, a value of C can be chosen to suit by using a little judgment.

Surface

The surface of a propeller depends on the pressure per square inch allowed on the projected blade surface, but as the projected blade surface can only be found after the developed surface it is best to use the pressure per square inch on the developed surface. This lies between 9 and 12 pounds per square inch, neglecting that due to the depth of immersion of the screw. It is highest for fast vessels and lowest for the slower type of vessels and, as the revolutions are fixed by the type of vessel, it will be best to consider the pressure per square inch as a factor of the revolutions, as in the following:

Pressure per square inch on developed surface = $.00563\ R + 7.5$.

To show method of arriving at the principal dimensions of a propeller, the following example is taken:

Propeller For a Cross-Channel Steamer

Number of shafts = 3. $S.\ H.\ P.$ = 9,500 on three shafts.
Revolutions per minute of turbines = 520.
Speed of vessel = 23 knots. $\frac{E.\ T.\ P.}{S.\ H.\ P.} = .53$.

* Marshall Scholar.

C, coefficient for diameter of propeller, = 25.

Diameter of Propeller in Feet.—

$$\text{Effective thrust} = \frac{\text{S. H. P. on one shaft} \times \frac{\text{E. T. P.}}{\text{S. H. P.}}}{\text{speed of vessel in feet per minute}}$$

$$\text{Effective thrust} = \frac{9{,}500 \times 33{,}000 \times .53}{3 \times 23 \times 101.3} = 23{,}780 \text{ pounds.}$$

$$\text{Diameter} = \frac{\sqrt{23{,}780}}{25} = \frac{154.2}{25} = 6.17, \text{ say 6 feet 2 inches diameter.}$$

Pitch.—The apparent slip of propeller is given by the formula $.0206\,R + 12 = .0206 \times 520 + 12 = 22.712$ percent.

Required speed of screw to drive vessel at 23 knots

$$= 23 + \frac{22.7}{100} \times 23 = 23 + 5.22 = 28.22 \text{ knots.}$$

$$\text{Pitch} = \frac{28.22 \times 101.3}{520} = 5.49 \text{ feet, say 5 feet 6 inches pitch.}$$

Surface.—Pressure per square inch on developed surface $= .00563\,R + 7.5 = 10.42$ pounds per square inch.

$$\text{Area in square inches} = \frac{\text{effective thrust in pounds on one propeller}}{\text{10.42 pounds per square inch developed surface}}$$

$$= \frac{23{,}780}{10.4 \times 144} = 16 \text{ square feet, nearly.}$$

DIMENSIONS

Diameter—6 feet 2 inches.
Pitch—5 feet 6 inches.
Developed Surface—16 square feet.

It is a good policy when fixing up the propellers for fast vessels to keep the pitch on the small side and the surface and diameter on the large side, as this will allow for modifications after the trial, and, if necessary, the diameter can be slightly reduced, which will allow the turbines to be run a few revolutions faster to suit a less thrust at a higher velocity.

Summary of the foregoing notes:

Type of Vessel	Speed of Vessel, Knots	Approximate Revolutions of Turbines	E.T.P. / S.H.P.	Apparent Slip of Propeller, Per-cent	Pressure per sq. in. on Developed Surface, Pounds	Ratio of Developed Surface to Disk Area	C Coefficient for Diameter
Large ocean mail steamer	24 to 25	190 to 200	.53	16.5	8.75	....	23
Intermed'te ocean mail steamer	21 to 23	330	.55	18.8	9.35	.55	24.6
Cross channel steamer	24	500 to 550	.53	20.5	10.3	.535	25
Fine-lined fast vessel	28	750	.52	27.5	11.72	.73	30

$$\text{Diameter of propeller in feet} = \frac{\sqrt{\text{Effective thrust in pounds.}}}{C}$$

Apparent slip of propeller, percent, $= .0206\,R + 12$.
Pressure per square inch of developed surface $= .00563\,R + 7.5$.

Constructional Details

The length of the propeller boss is fixed by the compressive stress per square inch allowed on the sides of the keyway in the boss, due to the tangential force of the turning moment on the propeller shaft, and to arrive at this stress the diameter of the shaft and the size of the propeller key must be known.

A suitable example will illustrate the method used, and, for preference, the propeller for the channel steamer will be taken.

Size of Tail-End Shaft

Let S = diameter of shaft in inches.
$I.H.P.$ = estimated maximum indicated horsepower transmitted through shaft.
R = revolutions per minute of shaft.
f = 60.3 for tunnel shafts.
f = 82.8 for propeller shafts.

Then the Board of Trade's formula for turbine shafts is

$$S = \sqrt[3]{\frac{I.H.P. \times f}{R}}$$

Now the indicated horsepower of a turbine is generally taken to be the shaft horsepower divided by .9. Then the indicated horsepower per shaft for a channel steamer with three shafts is

$$\frac{9{,}500}{3 \times .9} = 3{,}518\ I.H.P.$$

and the size of the propeller shaft is

$$\sqrt[3]{\frac{3{,}518 \times 82.8}{520}} = 8\tfrac{1}{4} \text{ inches, nearly.}$$

Size of Key

There are generally two keys in the propeller shaft, as shown in Fig. 2. To get the shear stress in the keys, first

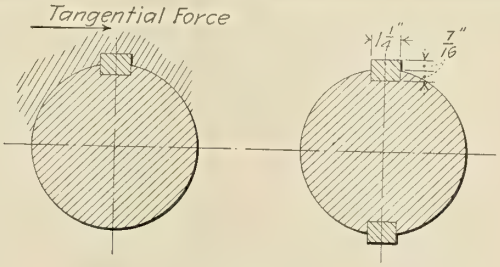


Fig. 1 Fig. 2

take the length of taper on propeller shaft. Rule for taper = 2.1 × diameter of propeller shaft in inches. Then, length of taper on shaft ends = 2.1 × 8¼ = 17½ inches. Now the keys are made ½ inch less at each end than the length of the taper, and the length of the key is 16½ inches long. From this the breadth of the key can now be arrived at by allowing a shear stress of 2,500 pounds per square inch through the cross section of the key where it intersects the shaft diameter. The stress, 2,500 pounds, is that generally used for medium type propellers, and it is taken up to 3,000 pounds per square inch for fast, high speed propellers, and for low speed propellers, 2,000 pounds shear stress is allowed. If a higher stress than 3,000 pounds per square inch is allowed through the cross section of the key, the tangential pressure on the key becomes abnormal and would necessitate a larger standout of key into the propeller boss, which only weakens the boss, so it is better to keep the shear stress in the keys between the figures given above.

Key to Channel Steamer Propeller

The shaft is 8¼ inches diameter, the taper on shaft 17½ inches long, and this taper is generally 1 in 12. Therefore, the diameter of shaft at centerline of propeller is

$$8\tfrac{1}{4} - \frac{8\tfrac{1}{4}}{12} = 7\tfrac{1}{2} \text{ inches.}$$

Tangential force on shaft at this diameter

$$= \frac{\text{S. H. P. on one shaft} \times 33{,}000}{\frac{7\frac{1}{2}}{12}\pi \times \text{revolutions}} = \frac{9{,}500 \times 33{,}000}{3 \times \frac{7.5}{12}\pi \times 520}$$

$$= 102{,}100 \text{ pounds.}$$

$$\text{Breadth of keys} = \frac{\text{tangential force}}{\text{length of key} \times 2 \times \text{shear stress (because there are two keys)}}$$

$$= \frac{102{,}100}{2{,}500 \times 16\frac{1}{2} \times 2} = 1\frac{1}{4} \text{ inches, nearly.}$$

$$\text{Depth of standout of key into propeller loss} = \frac{\text{tangential force on one key side}}{\text{area of side of key in way of propeller boss} \times \text{compressive stress allowed}}$$

The compressive stress allowed is as follows: 9,000 pounds per square inch for light, fast running propellers;

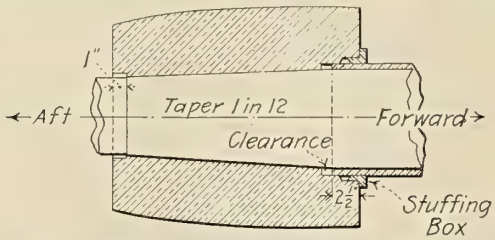


Fig. 3.—Sketch Showing Allowance on Forward and After Ends of Propeller Boss

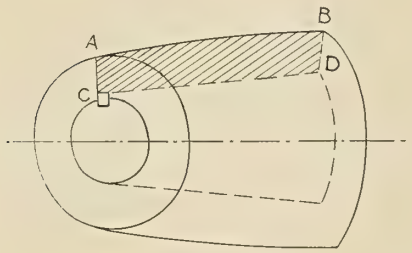


Fig. 4

6,000 pounds per square inch for propellers where weight is not considered too much.

Allowing a stress of 7,100 pounds on side of key, the standout or height of key becomes

$$\frac{102{,}100}{16.5 \times 2. \times 7{,}100} = 7/16 \text{ inch.}$$

Diameter of Propeller Boss

The diameter of the boss should be about twice the diameter of the propeller shaft, provided there is sufficient metal through the cross section of the boss in way of the key to prevent it bursting or cracking owing to the thrust on the taper of propeller shaft.

Length of Boss

The length of the propeller boss is the length of the shaft end plus 1 inch allowed on the aft end to enable the boss to be bored out to a slightly larger taper if necessary when fitting a new tail end shaft, and also 2½ inches to be allowed at forward end of taper to fit a small stuffing box and to allow clearance at end of shaft taper for tightening up purposes.

Propellers designed for high speed boats, where weight is cut down to the utmost limit, have usually a small diameter propeller boss, and this is fixed up by the bursting stress allowed through the cross section of the boss. Thus bursting stress may be allowed to go as high as 9,500 pounds per square inch, but it is not advisable to do this in ordinary practice.

Bursting stress in boss through area $A\ B\ C\ D$ (Fig. 4):

$$= \frac{\text{total thrust} \times \text{reciprocal of taper}}{\text{area } A\ B\ C\ D}$$

Example.—Size of boss for cross channel steamer propeller, allowing a bursting stress of 5,000 pounds per square of cross section of boss. Length of boss = length of taper + 3½ inches = 21 inches.

$$\text{Total thrust} = \frac{S.\ H.\ P. \text{ on one shaft} \times 33{,}000}{\text{speed in knots} \times 101.3}.$$

$$\text{Then thickness of metal} = \frac{S.\ H.\ P. \times 33{,}000 \times 12}{\text{length of boss} \times V \times 101.3 \times 5{,}000}$$

$$= \frac{9{,}500 \times 33{,}000 \times 12}{3 \times 21 \times 23 \times 101.3 \times 5{,}000} = 5\frac{1}{4} \text{ inches, nearly.}$$

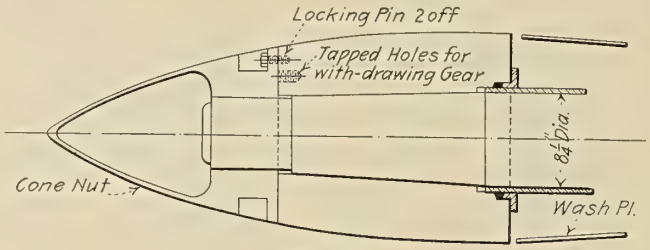


Fig. 5

Shape of Boss

A large cone nut is fitted to the propeller to overcome the frictional loss due to the propeller boss. This cone nut should be the same length as the propeller boss and forms with the boss a true stream line shape (see Fig. 5).

If the diameter of the propeller boss is different from that of the strut bearing, the wash or eddy plates must be made to suit.

In choosing the diameter of the propeller boss, it should be noted that a large diameter boss is more efficient than a small one, as the thrust near the boss is small; and not only that, a large boss allows the lock pins which hold cone nut from turning and the holes for withdrawing gear to be kept away from small end of taper, and also allows of a large size of withdrawing screw being fitted.

A short stuffing box is fitted to the forward end of the boss to prevent water creeping along the shaft taper, and this stuffing box is packed with an india rubber washer.

Cone Nut

The cone nut for the propeller is screwed opposite hand to the propeller and has two flats cut on it to engage the spanner for tightening up. Care should be taken when designing this nut to have sufficient length of thread to take propeller thrust when going astern and the length of nut should be equal to the small end of the shaft taper at the very least. The thickness of metal in the thin stream line portion of the cone nut should be ⅜ inch for small propellers and ⅝ inch for large ones.

Gland at Forward End of Boss

This gland is to be made in halves and is fitted with ¾-inch, square-necked studs about 3½ inches pitch.

Thickness of Blade Root

There are two forces acting on the root of the propeller blade, namely, the bending moments, due to the thrust and the tangential force of the turning moment of the propeller shaft, also the centrifugal force due to the weight of the propeller blade and the revolutions. These bending moments are caused by the resolved forces of the thrust and tangential forces acting at a radius equal to the distance from the center of the shaft to the center of thrust minus the radius of the propeller boss. The center of thrust for average blades is taken to be ⅝ radius of

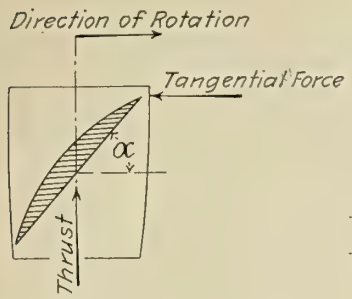


Fig. 6.—Forces Acting on Root Section of Blade

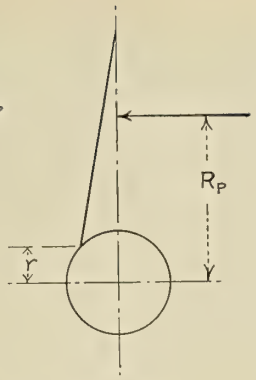


Fig. 7

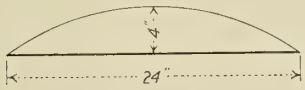


Fig. 8

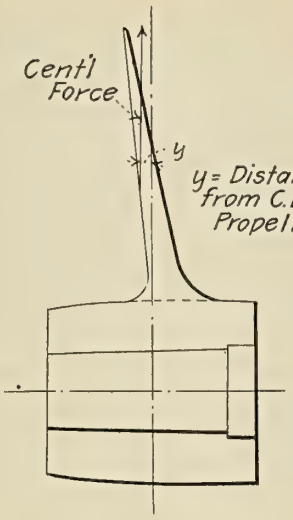


Fig. 9.—Sketch Showing Effect of Centrifugal Force on Root Section of Set Back Blade.

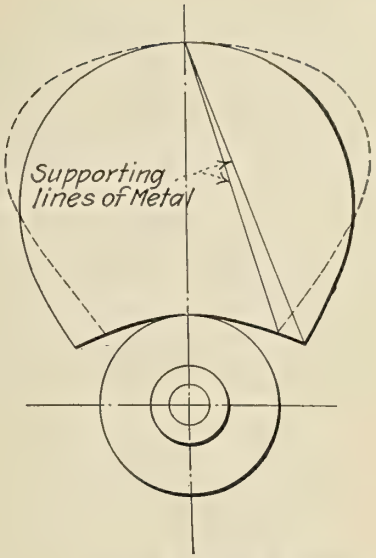


Fig. 10.—Sketch Showing Blade Shapes

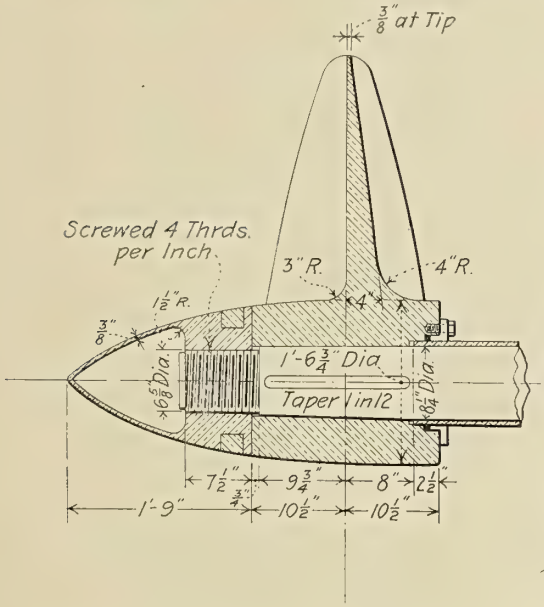
the propeller from the centerline of the shaft, and the resolved forces become (see Fig. 6)

Resolved force of thrust = Total thrust in pounds × cosα
Resolved tangential force = Tangential force × sinα

$$\text{Total thrust on one blade} = \frac{S.H.P. \text{ on one shaft} \times 33{,}000}{\text{number blades} \times V \times 101.3}.$$

$$\frac{S.H.P. \text{ on one shaft} \times 33{,}000}{2\pi \dfrac{\frac{5}{8} R_P}{12} \times \text{revolutions}}$$

and this acts at a leverage of ⅝ radius of propeller minus



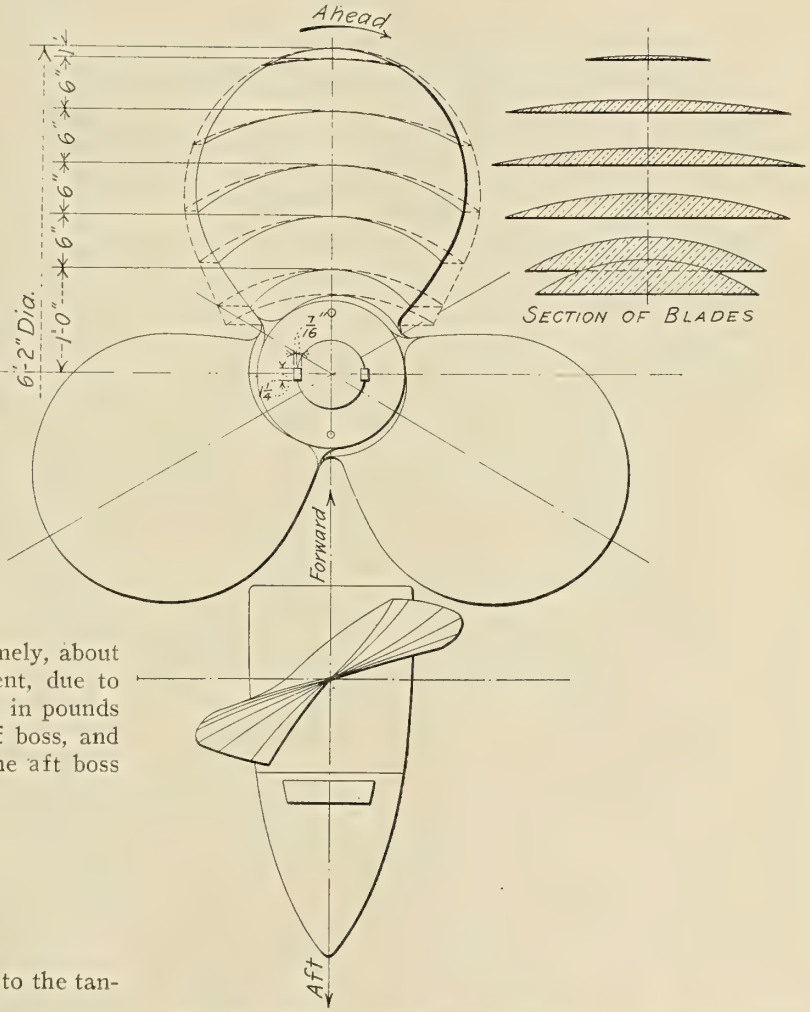


Fig. 11.—Right Hand Screw Propeller for Channel Steamer. Diameter, 6 Feet 2 Inches; Pitch, 5 Feet 6 Inches; Developed Area, 16 Square Feet; Projected Area, 14.2 Square Feet

This force will act at the center of thrust, namely, about ⅝ radius of propeller, and the bending moment, due to the resolved force of the thrust = Total thrust in pounds cosα × ⅝ radius of propeller minus radius of boss, and the stress in the blade root in tension along the aft boss of the blade will be

$$\frac{\text{thrust} \cos\alpha \times \frac{5}{8} R_P - \text{radius of boss}}{\text{modulus of section}}$$

$$\text{Modulus of section} = \frac{Bh^2}{9}$$

Again to this stress we must add the one due to the tangential force of the turning moment.

Tangential force due to turning moment of shaft at ⅝ radius of propeller equals

radius of boss. To simplify these stresses the following will be used:

Let $S.H.P._1$ = $S.H.P.$ on one shaft.
T_1 = total thrust divided by number of propeller blades.
R_p = radius of propeller in inches.
r = radius of propeller boss in inches.
V = speed of vessel in knots.
R = revolutions per minute of screw.
α = angle in degrees that blade root makes with *athwartship* centerline.
h = thickness of blade root in inches.
B = width of blade root in inches.
f_c = tensional stress in blade root due to centrifugal force (not to exceed *3,000* pounds per square inch).
f_t = tensional stress in blade root due to thrust and tangential force. This stress is kept between *5,000* and *8,000* pounds per square inch so as not to exceed a safe stress when the stress due to the centrifugal force is added to it.

The easiest method to be used to get the thickness at the root of the blade is to reduce the bending moments to a known force and then equate this to the modulus of section of the blade root times stress to be allowed, then

$$h = \sqrt[2]{\frac{9(\text{thrust } B.M. + \text{tangential } B.M.)}{B \times f_t}}$$

When h is found, try out the stress due to the centrifugal force on the root section by the following:

$$f_c = \frac{.00034\, W \frac{R_p}{12} R^2}{\frac{2}{3} Bh}$$

where W = weight of one propeller blade in pounds, and if this stress, together with the other stress due to the bending moments, exceeds the safe stress allowed, increase h and again try out stress. It is best to use the method given above, as combining the stresses and trying to get the thickness of the root by a shorter method lead to confusion of the terms involved.

Example.—Thickness of blade root for channel steamer propeller. Breadth of blade = 24 inches.

$$T_1 = \frac{9{,}500 \times 33{,}000}{9 \times 23 \times 101.3} = 14{,}900 \text{ pounds.}$$

α = 50 degrees. Resultant force = 14,900 Cosα = 9,550 pounds. Tangential force at $\frac{5}{8} R_p$

$$= \frac{9{,}500 \times 33{,}000}{3 \times 2\pi \times 1.93 \times 520} = 16{,}600 \text{ pounds.}$$

16,600 sin. α = 12,800. Add these two together

9,550

= 22,300 pounds, and this acts at
radius = $R_p - r = 23.2 - 9.375 = 13.825$ inches.
$B.M.$ = 22,300 × 13.825 = 308,100 inch pounds.

Allow a stress of 7,000 pounds per square inch in tension along aft face of root and

$$h = \sqrt[2]{\frac{9 \times 308{,}100}{24 \times 7{,}000}} = \sqrt{16\tfrac{1}{2}} = 4.06, \text{ say 4 inches.}$$

Now try out the centrifugal force acting on this root section (Fig. 8) with weight of one blade, say 400 pounds

$$= \frac{.00034 \times 400 \times 1.93 \times 520 \times 520}{2/3 \times 24 \times 4}$$

= 1,100 pounds per square inch.

Then total stress at root section = 1,100 + 7,000 = 8,100 pounds per square inch. The tension at the root is only dealt with, as high tension bronze is weaker in tension than compression, the ultimate strengths being tension, 26 to 30 tons, compression, 60-70 tons per square inch.

Set Back of Blade

The propeller blades of turbine vessels should not be set back as in reciprocating practice, because this greatly increases the bending moment on the blade root owing to the centrifugal force of the blade acting outside the root section. (See Fig. 9.) A small set back on a very fast running propeller will raise the root stress by as much as 2,000 to 3,000 per square inch.

Thickness of Blade Tips

The thicknesses of blade tips should be as follows: 5-foot diameter propeller, 5/16 inch at tip; 12-foot diameter propeller, ¾ inch at tip.

The propeller blades should be finely polished to reduce skin friction, and where the propeller blade joins the boss a generous radius should be allowed.

Shape of Blade

The blade should be made as near as possible to a disk-like shape (see Fig. 10), as this shape is found to give very good results in practice. Pear-shaped blades, shown by dotted lines in Fig. 10, cause undue vibration, as the outer edges of the blades are too far from the line of support, which is a line drawn from the top of the blade to the root edge.

How Our Navigation Laws Compare with Others

The navigation laws of the United States have been a subject of spirited controversy of late. It has been stated that the navigation laws of the United States are inadequate and that they impose undue hardships on our merchant marine. On account of the lack of published information on the subject, there has been no direct means of determining whether or not these statements are correct. In order to set forth clearly and concisely the exact facts in reference to the navigation laws of the principal maritime countries of the world, the Bureau of Foreign and Domestic Commerce, Department of Commerce, will issue, within the next two or three weeks, an exhaustive report on the principal features of the navigation laws of Great Britain, Germany, Norway, France, Japan, and the United States. No such work has ever before been attempted in the United States, and it will be invaluable to those who are studying the problem of our shipping and merchant marine.

This publication will present the principal features of the navigation laws of the different countries in such a way to show just how our laws differ from those of other maritime countries. The abstracts of the laws were obtained direct from the foreign maritime laws and have been submitted to competent officials of the various countries for criticism and revision. No conclusions are to be drawn and no attempt is to be made to enter one side or the other of the controversy that has been raging for months past with reference to our navigation laws.

Largest Plate Mill in the World.—The Lukens Iron & Steel Company, Coatesville, Pa., has placed a contract with the United Engineering & Foundry Company, Pittsburg, Pa., for the construction of a four-high plate mill of the type used for rolling armor-plate at the plant of the Carnegie Steel Company, the length of the rolls of which will be from 200 to 204 inches, and which will be capable of rolling plates about 16 feet in width. The largest plate mill in the world at present is located at Witkowitz, Hungary, and has rolls 178 inches long.

Calculations for Ship's Forms*

Formulae, Deduced from Model Basin Experiments, to Determine Dimensions of Propellers for Best Efficiencies

BY REAR ADMIRAL D. W. TAYLOR†

Since screw propellers came into common use, some seventy-five years ago, there have been innumerable theories of their action, and the screw propeller is still a favorite subject for the inventor. It is only within the last ten or fifteen years, however, since fairly extensive model-propeller investigations have been made public, that the fog—if I may so express it—surrounding propellers has begun to clear away. Even yet model experiments with propellers are not so generally accepted as those for ships. One outstanding result, however, of model-propeller investigations during the last few years is a demonstration of the fact that in former theories of propeller action an important factor has usually been overlooked. The vast majority of propellers have sections of ogival type, with a straight driving face and the back an arc of a circle, or very close to that curve. In dealing with such propellers, the only factors usually considered have been diameter, pitch and blade area—the pitch being the uniform or average pitch of the driving face. Now, the diameter is really the primary factor affecting the action of a propeller. The pitch of the face is a convenient but purely conventional measure. We know, as a matter of fact, that an ordinary propeller, as described above, will develop a very material thrust when its slip, based upon the pitch of its face, is zero. In other words, with such a propeller the virtual pitch is always greater than the nominal or conventional pitch. The factor which has been ignored in this connection is the thickness of the blade, or, what amounts to the same thing, the shape of the back of the blade. The back of the blade has a very powerful influence on propeller action, and for the ordinary type of propeller described above, its shape is dependent upon the thickness of the blade. The amount of this influence was not at all realized until it was investigated by model experiments. For instance, published results of experiments at the U. S. Model Basin‡ show that two model propellers, each 16 inches (0.407 m.) in diameter, 19.2 inches (0.487 m.) face pitch, with a ratio of projected area to disk area of 0.3023, but differing in blade thickness, one being abnormally thin and the other abnormally thick, showed radically different results. Thus, at 5 knots speed of advance and 20 percent slip, the thin blade showed a thrust of 35 pounds (15.9 kg.), whereas the thick blade showed a thrust of 51 pounds (23.1 kg.), an increase of nearly 50 percent.

Blade area or surface is very unsatisfactory as a primary variable. This is essentially for the reason that the effect of variation of blade area depends upon how it is varied. In the case of a given propeller, if we increase blade area by increasing diameter, without materially changing the width of the blade, the effect is great. If we make the same increase of blade area by increasing the width of the blade, without increasing diameter, the effect is comparatively small; and if, as is apt to be the case in such instances, the increase is accompanied by a reduction of thickness, we may get no effect at all. For this reason, in any theory of propeller action, it is desirable to bring in the blade area in some manner which will make its effect always similar. Perhaps the most convenient method of doing this is to use, not the blade area, but the ratio of maximum or mean width of blade to the diameter.

In this way, any change of blade area due to change of diameter is taken up by the diameter factor, and the change of area due to change of width is taken up by the width coefficient, or, as it is conveniently called, the mean-width ratio. In any reliable propeller theory, then, we must take account of the diameter and mean width of the blade, and the real pitch. In practice, the real or virtual pitch depends partly upon the nominal pitch of the face, and partly upon the blade thickness. It is convenient to separate these factors and use as variables the nominal pitch and what I have called the "blade thickness fraction," namely, the ratio between the root thickness of the blade at the axis (obtained by extending the straight lines of face and back to the shaft center), and the diameter of the propeller. If we adopt these variables, it is possible, by semi-empiric methods, to express the results of any systematic series of propeller experiments by formulæ. Of course, the results of such experiments must first be expressed graphically, and, for practical purposes, complete graphic expressions are as good as formulæ; but most people seem to prefer to work out a result by means of a formula rather than from graphic data.

Some years ago* there were published the results of experiments, at the U. S. Model Basin, with 120 different model propellers, varying in pitch and mean-width ratio and blade thickness. These were three-bladed propellers, the blades being elliptical. Careful analysis of the results of these experiments shows that they may be expressed with close approximation by formulæ, which, though somewhat complicated, are not too inconvenient for use.

Let P denote the horsepower being absorbed by the propeller.

Let T denote the thrust of the propeller in pounds. (Kilograms in metric system.)

Let V denote speed of advance of the propeller (not the ship) through the water, in knots.

Let d denote diameter of propeller in feet. (Meters in metric system.)

Let p denote pitch in feet of the driving face. (Meters in metric system.)

Let a denote pitch ratio or $p \div d$.

Let w denote mean-width ratio or (mean width of blade $\div d$).

Let t denote blade-thickness fraction, or (thickness of radial blade section at axis if lines of face and back are extended) $\div$ diameter.

Let R denote revolutions per minute.

Then

$$\text{Slip, } s, = \frac{pR - 101\tfrac{1}{3}\,V}{pR}.$$

In metric units,

* From a paper presented at the International Engineering Congress, San Francisco, Cal., September, 1915. (For previous installment see October, 1915, issue.)

† Chief Constructor, United States Navy

‡ "The Speed and Power of Ships," by D. W. Taylor, 1910.

* "Speed and Power of Ships." By D. W. Taylor, 1910.

$$s = \frac{pR - 30.9\,V}{pR}.$$

For blade widths and thicknesses and working slips found in practice, we have for elliptical three-bladed propellers, with blades of ogival section, advancing through undisturbed water

$$T = \frac{d^2v^2}{(1-s)^2} \times \frac{s + \frac{.057}{w} - .0785 + a\left(.015 - \frac{.0175}{w}\right) + \left\{2.54 - 32\,(w-.15)^2\right\} t}{.2 + (a-.5)\,\frac{9.8 - 16\,w}{9}}$$

In metric units,

$$T = 4.883\,\frac{d^2v^2}{(1-s)^2} \times \frac{s + \frac{.057}{w} - .0785 + a\left(.015 - \frac{.0175}{w}\right) + \left\{2.54 - 32\,(w-.15)^2\right\} t}{.2 + (a-.5)\,\frac{9.8 - 16\,w}{9}}$$

For working slips, say, between $s = 0.2$ and $s = 0.35$ and for values of w between, say, 0.25 and 0.40, this formula represents almost exactly the results of the model-

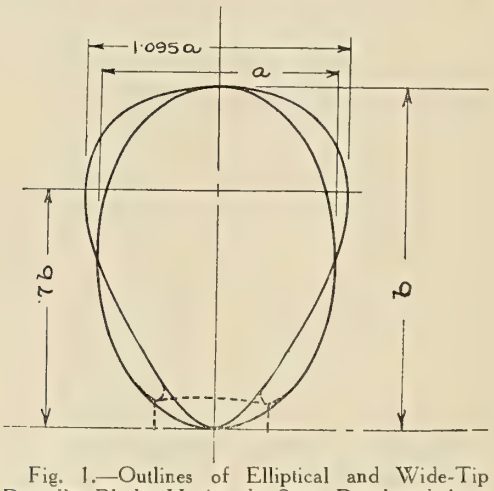


Fig. 1.—Outlines of Elliptical and Wide-Tip Propeller Blades Having the Same Developed Area and Mean Width Ratio

propeller experiments at the U. S. Model Basin. While not quite so close, the agreement with a series of experiments made by Mr. R. E. Froude* with elliptical propellers is quite close enough for practical purposes. While the formula includes the mean-width ratio, w, the influence of this factor is comparatively small. Thus in Froude's experiments, above referred to, an increase of some 10 percent in mean width, other circumstances being unchanged, results in an increase of only about 1 percent in thrust.

While this semi-empirical formula applies strictly to elliptical blades, the shape may depart materially from the elliptical and the formula will still apply fairly well. Fig. 1 shows, contrasted with an elliptical blade, an extremely wide-tipped blade of the same area experimented with by Froude. The thrust from the wide-tipped blade is only some seven or eight percent greater than that given by the formula for the elliptical blade.

When we undertake to devise a semi-empirical formula for the power absorbed by an elliptical-bladed propeller, it is found that variation of blade width affects it so little that, for practical purposes, we need not consider w in the formula for power, which is

$$P = \frac{0.88 + \frac{0.69}{a} + \left(1.3 + \frac{10.3}{a}\right) t}{1-s} \left(\frac{pR}{1{,}000}\right)^3 \frac{d^3}{p}$$

We may write this

$$\frac{P\,(1-s)}{\left(\frac{R}{100}\right)^3} = \left\{0.88 + \frac{0.69}{a} + \left(1.3 + \frac{10.3}{a}\right) t\right\} \frac{d^3p^2}{1{,}000} = C, \text{ say.}$$

In metric units,

$$\frac{P\,(1-s)}{\left(\frac{R}{100}\right)^3} = \left\{0.88 + \frac{0.69}{a} + \left(1.3 + \frac{10.3}{a}\right) t\right\} 0.380\,d^3p^2 = C$$

Where C is constant and known for a given propeller.

Derived from this, the equation,

$$1 - s = \frac{C}{P}\left(\frac{R}{100}\right)^3$$

will be found very useful for approximating the real slip, as contrasted with the apparent slip, when analyzing trial results.

Examination and consideration of the above formulæ and of the experimental results which they represent show, as to be expected, that for cases as found in practice the slip is the main factor and the variation of slip incident to a permissible variation of revolutions for a given power will overshadow the effect of usual variation of blade width and thickness.

For a final approximation, then, for design purposes, the experimental results give the following for three-bladed propellers with elliptical blades, mean-width ratio from 0.25 to 0.40 and blade-thickness fractions such as are found in practice.

For best efficiency

$$d = \frac{(PV)^{1/5}}{R^{2/3}}\left(63.5 - 50\,\frac{V^{5/2}}{RP^{1/2}}\right)$$

In metric units,

$$d = \frac{(PV)^{1/5}}{R^{2/3}}\left(19.1 - 15.3\,\frac{V^{5/2}}{RP^{1/2}}\right)$$

Pitch ratio,

$$a = 0.74 + 3.3\,\frac{V^{5/2}}{RP^{1/2}}$$

Efficiency

$$= 0.768 - 0.01\,\frac{RP^{1/2}}{V^{5/2}}$$

For propellers with smaller diameter and working with .025 less efficiency

$$d = \frac{(PV)^{1/5}}{R^{2/3}}\left(57 - \frac{50\,V^{5/2}}{RP^{1/2}}\right)$$

In metric units,

$$d = \frac{(PV)^{1/5}}{R^{2/3}}\left(17.4 - \frac{15.3\,V^{5/2}}{RP^{1/2}}\right)$$

Pitch ratio,

* "Results of Further Model Screw Propeller Experiments," Transactions of the Institution of Naval Architects, 1908.

$$a = 1.08 \frac{3.3\, V^{5/2}}{RP^{1/2}}$$

Efficiency

$$= .743 - .01 \frac{RP^{1/2}}{V^{5/2}}$$

For propellers with larger diameter and working with .025 less efficiency

$$d = \frac{(PV)^{1/6}}{R^{2/3}} \left(70 - \frac{50\, V^{5/2}}{RP^{1/2}} \right)$$

In metric units,

$$d = \frac{(PV)^{1/6}}{R^{2/3}} \left(21.3 - \frac{15.3\, V^{5/2}}{RP^{1/2}} \right)$$

Pitch ratio,

$$a = .52 + \frac{3.3\, V^{5/2}}{RP^{1/2}}$$

Efficiency

$$= .743 - .01 \frac{RP^{1/2}}{V^{5/2}}$$

For four-bladed propellers, with close approximation the diameter, pitch and efficiency are, respectively, 0.94, 0.98 and 0.96 of those for three-bladed propellers; while for two-bladed propellers they are 1.035, 1.01 and 1.02.

The preceding formulæ assume that the law of comparison applies fully and that the speed of advance, V, of the propeller through the water is known. If the law of comparison did apply to all cases, with the data which have now become accumulated from model-propeller experiments, the propeller problem would, in practically all cases, be capable of a solution in advance sufficiently close for practical purposes, if not of scientific accuracy. As a matter of fact, the law of comparison does apply with close approximation to the majority of practical cases. For the propeller, however, as for the ship, in order that the law may apply exactly, the pressures should be in the same ratio as the dimensions. This, of course, is not the case. The model propeller is tested under a head of, perhaps, 1 foot (.3 m.), due to submergence, and 34 feet (10.4 m.), equivalent to the atmospheric pressure. The full-sized propeller operates with submergence in proportion to its size, but the head due to atmospheric pressure is the same for the full-sized propeller as for the model. Hence we find that with some full-sized propellers, particularly the high-speed type, the now well-known phenomenon called "cavitation" occurs, while there is no indication of it with the models of such propellers. Since Barnaby first described cavitation,* as observed in the trials of the *Daring* many years ago, there has been much study and thought given to it, but the only process, in practice, which has been generally satisfactory in reducing or avoiding it is increase in blade area and reduction of the thickness of the blades (particularly at the leading edge) to the limit permissible by practical considerations.

The many endeavors to devise a form of blade section of moderate width which the water will continue to hug when the speed of the blade through the water is extreme, have not heretofore been strikingly successful. It is possible that they may show some success in the future, enabling the propeller designer to adopt a type of blade somewhat more efficient than the very wide blade, whose friction is apt to be excessive. Even so, the gain would not be very great, as the loss of efficiency due to the broad blade is not very serious.

Attempts accurately to define the region where cavitation is to be expected have not, hitherto, been very successful. The limiting thrust per unit of projected area originally proposed by Barnaby has been materially exceeded in some cases without cavitation, while in other cases cavitation has been found with much lower thrusts. The same statements virtually apply to tip speed, which is, perhaps, a somewhat better criterion. Here again, the shape of the blade section is a matter of primary importance. For a given type of blade section we may adopt either tip speed or thrust as a criterion, with fairly satisfactory results, provided we do not go beyond the limits which have been found satisfactory for the same type of blade in other cases.

Attempts have been made to investigate cavitation with models. Sir C. A. Parsons has made experiments along this line with hot water, or in a partial vacuum. The idea, in each case, was to reduce the pressure around the model in proportion to its size. Little or nothing of value in defining the field of, or in avoiding, cavitation, has been published as a result of these experiments.

The formulæ given, derived from model experiments, assume, as already stated, that V, the speed of advance through the water, is known. When we come to apply the propeller at the stern of the ship we do not know, as a rule, the speed of advance through the water. The propeller acts in the wake of the ship and in most cases the wake is positive, which means that the speed of advance of the propeller through the disturbed water in which it works is less than the speed of the ship. Model experiment investigations have been made by R. E. Froude,* and notably by W. J. Luke,† of late years, using a model propeller behind the model of the ship. This method enables not only the wake but the thrust deduction, or suction of the propeller upon the stern of the ship, to be investigated. From Luke's results we may roughly express the wake as follows:

Let k denote the actual wake fraction, the virtual uniform following current in which the propeller acts being equal to kV, where V is the speed of the ship. Let b denote block coefficient. Then for single screws $k = 0.05 + 0.5b$. For twin screws $k = 0.2 + 0.55$b. These are very rough approximations, as reference to Luke's papers will show that the wake varies with the position of the screws and also with their direction of rotation. The wake means a gain in efficiency, whereas the thrust deduction means, of course, a loss as compared with the case where the propeller is driving what R. E. Froude has happily called a "phantom ship," namely, a ship which offers the resistance of the actual ship but does not disturb the water. It is usually assumed that the wake gain and thrust deduction virtually offset each other as regards efficiency. This is, actually, not exactly the case, and this whole matter of wake factor and thrust deduction is one needing a thorough clearing up. The assumption that the wake is uniform is, of course, simply a working hypothesis for convenience, the actual wake being far from uniform. This was demonstrated many years ago in some experiments made by Mr. George A. Calvert.‡ Experiments recently made at the U. S. Model Basin, with special apparatus, throw additional light upon this matter.

When fluid is flowing past a sphere, or a sphere is advancing into still water, the excess pressure on the sphere (above that due to its submergence) immediately around

* The Formation of Cavities in Water by Screw Propellers at High Speed," Sydney W. Barnaby, Transactions of the Institution of Naval Architects, 1897.

* "A Description of the Method of Investigation of Screw Propeller Efficiency," Transactions of the Institution of Naval Architects, 1883. "The Determination of the Most Suitable Dimensions for Screw Propellers," Transactions of the Institution of Naval Architects, 1886.

† "Experimental Investigations of Wake and Thrust Deduction Values," Transactions of the Institution of Naval Architects, 1910. "Further Experiments on Wake and Thrust Deduction," Transactions of the Institution of Naval Architects, 1914.

‡ "On the Measurement of Wake Currents," Transactions of the Institution of Naval Architects, 1893.

the axis of advance is equivalent to the velocity head of advance, and the pressure at 90 degrees from the axis of advance is below the natural pressure due to submergence. Around some circle between the two, the pressure in the moving water around the sphere will be the same as the pressure in the undisturbed water at the same depth below

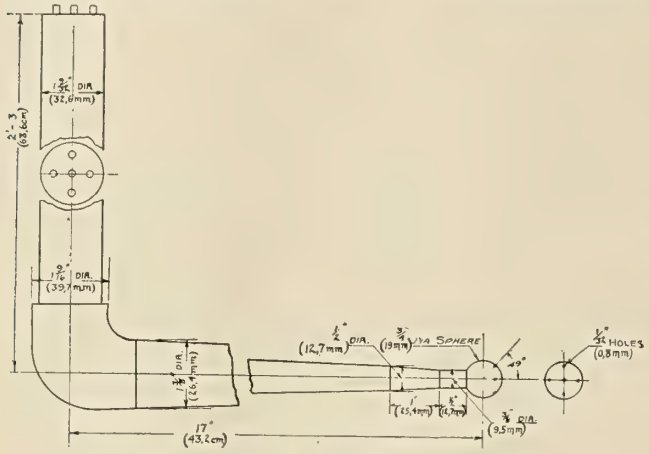


Fig. 2.—Sketch of Wake Meter Tube

the surface. In theory, this circle is 41° 49′ away from the axis. As a matter of fact, careful experiments with a ¾-inch (19 mm.) sphere showed that, due to friction or some other cause, the actual distance from the axis was almost exactly 49°. A ¾-inch (19 mm.) sphere, Fig. 2, was made with five holes 1/32 inch (0.8 mm.) in diameter, one in the axis, two on a horizontal line 49° away from the axis, and two on a vertical line 49° away from the axis. Each hole was connected with a vertical glass tube showing head and change of head. The sphere was on the end of a horizontal arm, which was carried, in turn, by a vertical tube sufficiently far away not to affect the motion around the sphere. The apparatus was calibrated from the Model Basin carriage, by advancing it with the axis of the tube or the central hole at various angles from both the vertical and horizontal. It was found that the difference between pressure head measured at the center hole and the average head of the other holes indicated the speed with great accuracy, and the differences of head shown in the tubes connected with the other holes enabled the angle of advance to be determined accurately, the error being no greater than a fraction of a degree. It was also found that this sphere could be placed so that its center would be within 1½ inches or so of a plane without the motion around it being materially affected, and, when placed closer, the variation from normal conditions could be calibrated. The sphere then being placed in any position near the stern of a model, whose speed through the water is known, and readings taken of the heights of water in the tubes connected with the various holes, we can determine the actual speed and direction of flow of the water.

Fig. 3 shows for a model the directions with reference to the axis of the vessel under way and the amounts of the wake currents at the points indicated. Since friction is relatively greater in a model than in a full-sized vessel, the amounts and directions of the wake of a full-sized vessel would differ slightly from those around the model, but it is not likely that the difference would be material.

Section B would be a fairly usual location for the propeller of this vessel, the circle indicating a propeller of 8 feet diameter for the full-sized vessel. It is seen, then, that the blades of such a propeller encounter most variable conditions during a revolution, the axial or fore and aft velocity of the wake varying from 4 to 23 percent. These axial velocities are for a vessel which has fine lines aft;

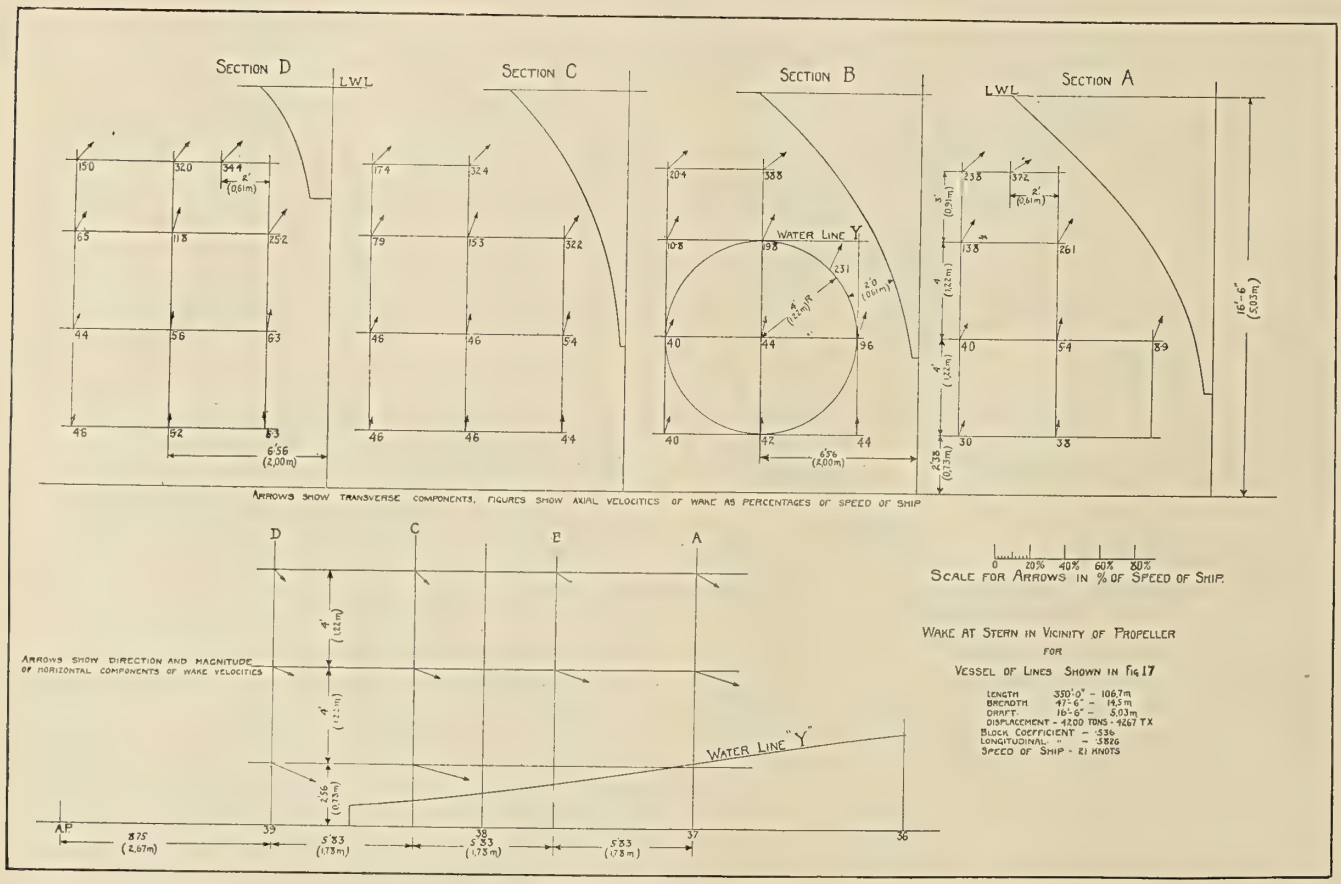


Fig. 3

for a full vessel, the wakes would be greater and the variations greater. It would seem evident that when the propeller must work under the conditions indicated by Fig. 3, fine-spun theories as to angles of slip, etc., in still water, are quite irrelevant as regards actual conditions. Incidentally, it may be remarked that the wakes indicated at distances from the hull, where the frictional wake would have little or no effect, agree very well in a general way with what would be expected from theoretical considerations of stream-line flow.

Some recent experience with United States vessels has emphasized the desirability of having strut arms parallel to the lines of natural flow of the water, and the apparatus referred to enables the proper angles to be readily determined. Sometimes these are far from what we would make them, if evolved from our inner consciousness.

[In a later issue the third and final instalment of this paper will be published, dealing with the subject of rolling of ships. In recent years there has been renewed interest in this important subject, and the investigations made of it, instead of being of academic interest only, are of great practical interest and value.—Editor.]

Modern Submarines in War and Peace—VIII

Application of the Submarine to Commercial Enterprises—Cargo-Carrying Submarines—Sea Bottom Exploration and Wreck Salvage

BY SIMON LAKE

The quite unexpected success of the naval submarine will perhaps now give financiers greater confidence in the value of the submarine for a great variety of commercial purposes, where its field for exploration, constructive work, and recovery of lost ships and cargoes, submarine mining and recovery of foodstuffs and other valuable natural products of the sea will make it, when it reaches its full development, one of the most important inventions of the age. All it needs is capital and experienced engineers and operators to take from the sea what the misfortunes of man (in the way of lost ships and cargoes) and nature has provided in such abundance.

Cargo-Carrying Submarines

The author has frequently been asked as to what is the limit in size of the submarine. That is a difficult question to answer, as it depends so much upon the depth of submergence, speed desired, etc. The usual circular-formed vessel, if designed to meet the present United States Government requirements of 200-feet depth of submergence,

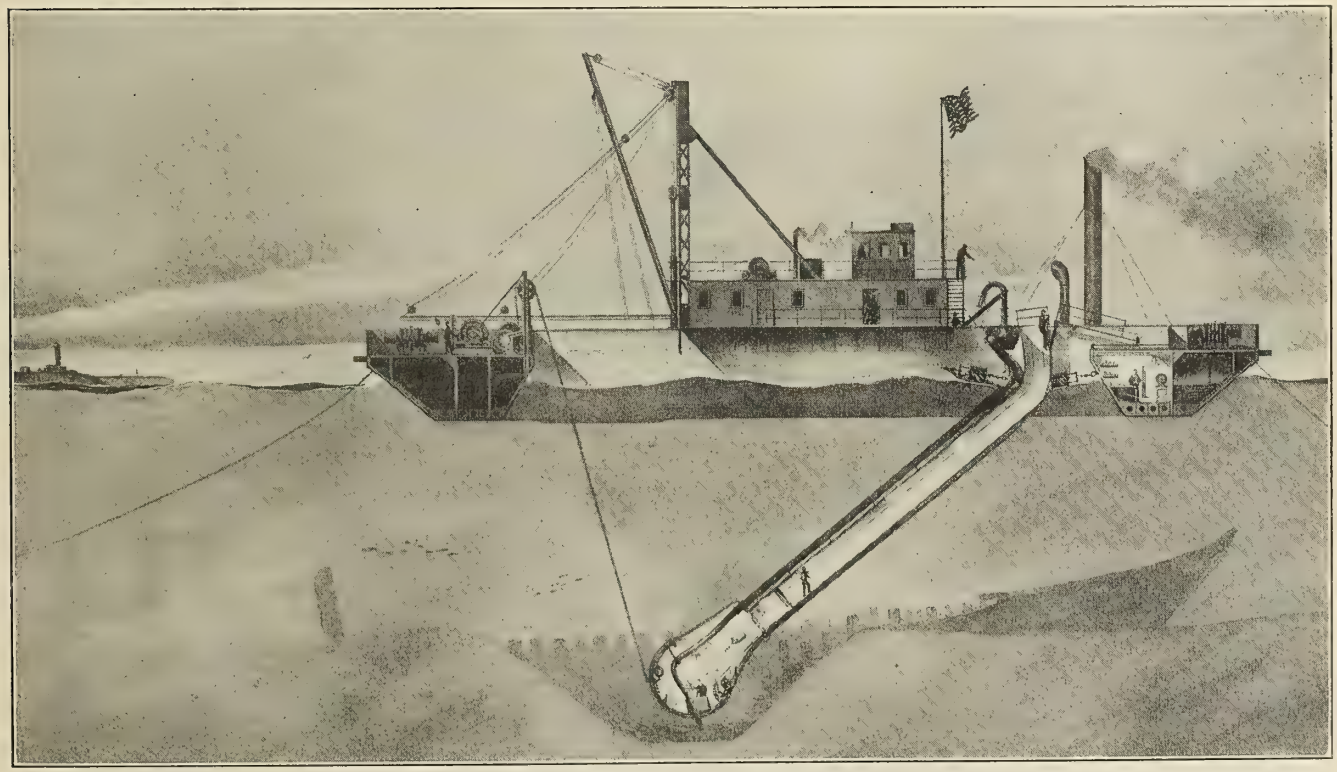


Fig. 55.—Semi-Submergible Wrecking Apparatus

The submergible tube has the diver's operating compartment shut off from the rest of the apparatus by means of an air lock which permits passage from the surface vessel and normal air pressure to the diver's compartment, where the air is under pressure equal to the compartment's depth of submergence, when the diver's exit door is open. The above illustration shows clearing out a vessel, from sand, by the use of a powerful sand pump to enable the salvors to get at the cargo. The same method would be employed in pumping up a cargo of coal. With this apparatus it is only necessary to "walk down stairs," so to speak, to go down into a sunken ship, and if necessary to send divers out they are convenient to tools and are not subject to the dangers incident to entanglements of life line and air hose when going down into the murky darkness from a surface vessel by jumping into the seas. No matter how much the surface vessel may jump about on the sea, the compartment at the bottom is still.

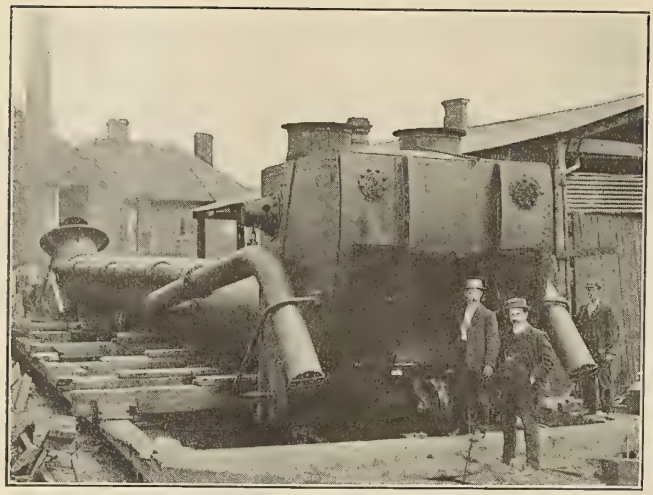


Fig. 56.—Experimental Submarine Wrecking Tube, Built by Mr. Lake in England to prove out the practicability of using an apparatus of this kind in connection with a surface vessel in wrecking operations

would need to be built of very heavy plates and frames, and would probably be of too great draft to enter our harbors if built to carry as much as 5,000 tons cargo. A submarine vessel built up of nests of cargo-carrying, light-weight circular tanks of comparatively small diameter, surrounded by a ship-shaped form of hull, has been patented by the author, which lends itself to much larger construction, and a greater safe depth of submergence on less weight of material and draft of ship.

The multiplicity of units would permit of a number of them being punctured by shell fire while in surface cruising condition without sinking the ship. If the present European war continues for a considerable period of time we shall probably see some form of cargo-carrying submarine constructed to be used as blockade runners.

Sea-Bottom Exploration

Investigation of the geological formation of sea bottoms, the flora and fauna of the sea, will be greatly assisted by bottom-creeping submarines. Fitted with powerful searchlights and moving-picture cameras, actual sea-bottom conditions may be reproduced up to depths of 1,000 feet or more. The author, in 1898, succeeded in taking photographs of fish through the windows of the *Argonaut* by means of an ordinary kodak, and last year the Williamson brothers showed in moving-picture houses throughout the country some wonderful submarine moving pictures they had secured by the use of their collapsible submarine tube.

In Southern waters it is possible to see considerable distances, and in certain localities the great variety of brilliantly colored fish swimming about among the varicolored kelp, sea grasses and corals. On a sunshiny day, when the play of lights from the undulating underneath surface of the water, which resembles a rippling, polished mirror, is a "sight" never to be forgotten and is well worth a thousand-mile voyage to witness. The writer is now engaged on the plans of a passenger-carrying submarine that will carry fifty passengers, and is to be especially built to enable people to view these "wonders of the

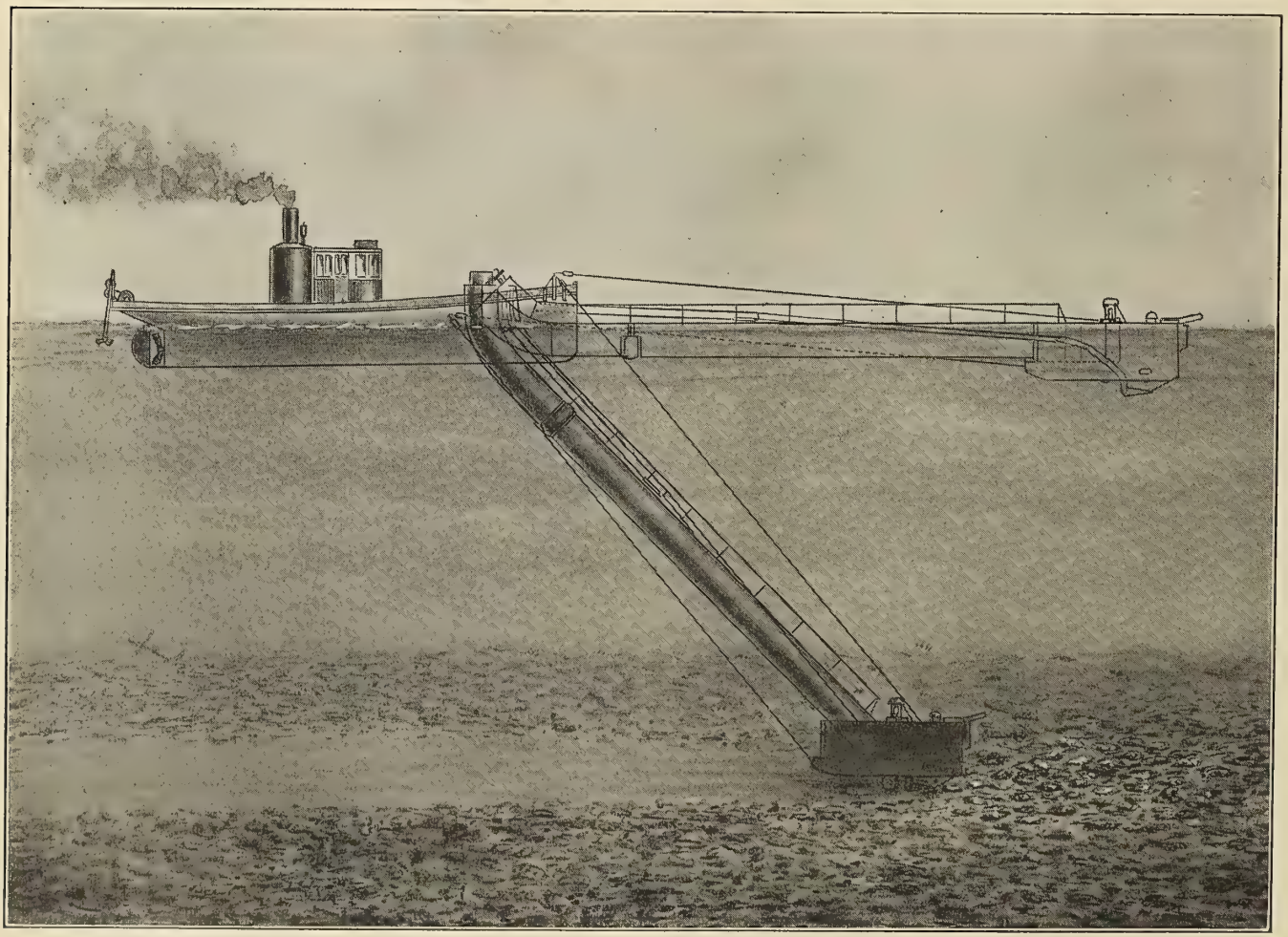


Fig. 57.—Submarine Boat Attached to Surface Vessel with Communicating Access Tube

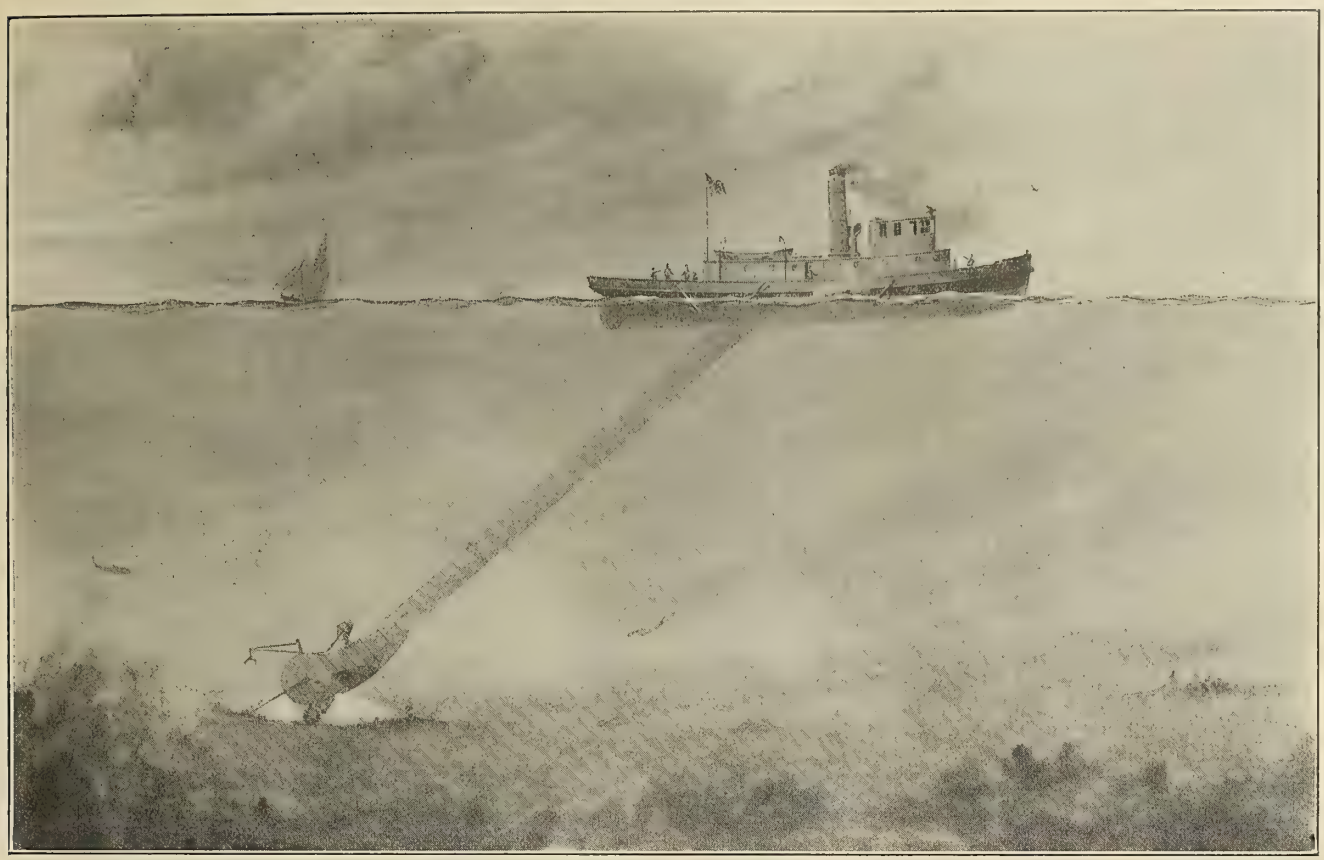


Fig. 58.—Submarine Apparatus for Use in the Pearl and Sponge Fisheries

The submarine tube has a working compartment at one end and is provided with water ballast tanks so that it may be submerged to the bottom. It is weighted so as to give sufficient traction to pull the surface vessel if desired, or the surface vessel may pull it over the bottom. A traction wheel to propel the compartment may be turned in any direction and is driven by a motor inside the operating chamber. Air pressure may be admitted to the operating chamber to equalize the hydrostatic pressure outside of the compartment, and then a door may be opened in the bottom and no water will enter the compartment. In this manner articles may be gathered directly off the bottom by hand or divers may leave the compartment by donning the regulation dress, or in deep water grabs or rakes may be manipulated from the interior and the product deposited in carriers which take the material to the surface, without the necessity of the operator undergoing pressure.

deep" which have heretofore been only partially available to native divers of the Southern seas or the few who have penetrated the depths for short intervals of time in the diving dress.

In this "sight-seeing" passenger-carrying "automobile" submarine it will be possible for the passengers to sit comfortably at their respective windows and view the coral formations and the submarine forests of kelp and other monster sea grasses, some of which grow to over one hundred feet in length, and watch the play of the great variety of fishes which abound among them.

Those of my readers who have viewed the submarine gardens at Bermuda, Nassau, or in the Caribbean Sea, or Catalina Islands, or San Diego, on the Pacific, through glass-bottom boats may have some comprehension of the beautiful sights that await those who may be privileged to actually go down among the "denizens of the deep" and see the full beauties of the most beautiful of nature's gardens in their natural perspective and coloring, instead of only the "plan" view, so to speak, when viewed from above.

Submarine Wreck-Finding and Recovery Boats

In searching for sunken vessels, two boats are used, of the same general type as the "hydrographic submarine." When a wreck is located, divers go out and examine it. If it is concluded that she has cargo on board worth salving, her location is plotted on the chart, and then the recovery boats are sent out to remove the cargo. The writer has done much experimental work in locating sunken wrecks and recovering their cargoes. In 1898, 1899 and 1900 the *Argonaut* and special wreck-finding apparatus were used in this experimental work. Numerous wrecks were found and a number of cargoes were profitably recovered, notwithstanding the fact that the apparatus used was crude and experimental. In 1901 I was called from this line of work to take up the construction of submarine torpedo boats, and have been too busy ever since building for the United States and foreign governments, and have not had the time and opportunity to push on this very interesting phase of submarine work.

Searching for sunken vessels is, perhaps, the most interesting of all submarine work. It is like fishing. One is always on the "qui vive" for a "bite." There is hardly a location along our coast or in Long Island Sound that does not have a tradition about lost treasure ships, and every time one gets a "bite"—that is, our lines get fast to some sunken object, excitement runs high in the expectation of some valuable find. In my experimental work in the vicinity of Bridgeport, Conn., we located sixteen sunken vessels, the great majority of them containing coal, which we recovered at a cost of about fifty cents (2/1) per ton. Most of these vessels had been sunk a long time. Only a few of them were known by name, and some had evidently been sunk many years. One that we searched for, for several months, had a cargo of copper ore and copper matte which was quite valuable. We finally found her several miles away from where people testified they saw her disappear.

Somewhere off Bridgeport lies the wreck of the old Sound steamer *Lexington*. Legend has it she has a for-

tune in her safe. Many a ship has been sunken in the waters about Hell Gate. Search was carried on there for years for the old British frigate *Hussar,* which struck on Pot Rock and sank during the Revolutionary War. Tradition has it that she had four million dollars (£820,000) in gold on board to pay off the British troops, and that she carried this treasure to the bottom with her. There is a cargo of block tin somewhere in a sunken barge off the Battery, and many a ship with valuable cargoes lies along the coast from New Foundland to Key West. The time will come when many of these ships will be found and such of their cargo as is still valuable will be salved.

Salving a sunken cargo is not a difficult engineering feat, providing the proper apparatus is at hand. It is the novelty of the enterprise and the mystery surrounding submarine work that makes it seem so difficult to the layman. Diving as heretofore conducted has been difficult and dangerous work, and only the strong could stand the hardships connected with it. The advent of proper machinery and scientific methods, however, will clear away many of the hardships and dangers connected with salving a sunken cargo, and more experience and proper apparatus will prove that certain cargoes may be removed from sunken ships in moderate depths with almost as much rapidity as they can be lifted from the hold of a vessel alongside of a dock. Take anthracite coal, for instance. With a six-inch pump, on the old *Argonaut,* I have transferred fifteen tons of nut coal from a sunken barge to a sunken freight-carrying submarine in nine minutes. A turn of the air valve then sent the sunken freight boat to the surface. The coal was transferred while all the boats were submerged in seven fathoms of water. It was this kind of experimental work which has enabled me to devise apparatus which will undoubtedly operate successfully on a much larger scale, as explained below.

The wrecking barge which is illustrated on page 75 is to be fitted with a 15-inch coal pump, which should recover any of the usual household grades of anthracite coal at the rate of ten tons per minute. All the manipulation of the suction pipe is done by power, instead of by hand by divers, as heretofore. Especially designed compensating hoists, operated from a pressure-resisting compartment right down on the job, permits breaking out cargo in comparatively rough weather. The divers operate within a few feet of a compartment and air lock, whereby they largely avoid the dangers incident to entanglement of life line and air hose, and whereby they can become gradually prepared for deep-water work by undergoing "stage" compression and decompression, which is the proper method, according to the latest scientific research. All the time which divers formerly spent being swung back and forth by the currents and jerked up and down by the action of the sea is avoided and the compression and decompression periods are undergone while at rest in a well-lighted and comfortable compartment. Diving work may therefore be carried on at much greater depths and for much longer periods of time than heretofore.

Statistics have been published to show that practically the entire commerce of the world sinks in every twenty-five years. A report from Berlin states that "734 enemy ships, with a tonnage of nearly one and half millions, have been sunk by the Germans, of which 568 of these ships were sunk by submarines."

Most of these vessels were sunk in the North Sea or the English Channel, where the water is comparatively shallow, and where many of the cargoes can undoubtedly be recovered with the proper apparatus. The loss of ships is such a common occurrence that little attention is paid to them except when their loss is accompanied by great loss of life, as was the case with the *Titanic,* the *Monroe,* the *Empress of Ireland,* or the *Lusitania.*

(To be continued.)

Pitches for Screw Stays

The following table gives the pitches for screwed stays for supporting flat plates, as worked out according to the United States Government rule in which the following formula is used:

$$\text{Pitch} = \sqrt{\frac{112 \times T^2}{P}},$$

where T = thickness of plate in 16th of an inch,
P = working pressure in pounds per square inch,
112 = constant for plates 7/16 inch and under.

The same formula is used for plates 15/32 inch and over by substituting 120 as the constant in place of 112 used in the above formula.

The areas and pitches in this table will be found to be correct, or, in some cases the pitches may be a little small, which favors the work.—*The Boiler Maker.*

Table of Pitches for Screwed Stays Supporting Flat Plates (U. S. Government Rules)

Plate	1/4		9/32		5/16		11/32		3/8		13/32		7/16		15/32		1/2		17/32		9/16		5/8		11/16	
W.P.	Area	Pitch	Area	Pitch	Area	Pitch	Area	Pitch	Area	Pitch	Area	Pitch	Area	Pitch	Area	Pitch	Area	Pitch	Area	Pitch	Area	Pitch	Area	Pitch	Area	Pitch
50 #	35.84	5.98	45.36	6.73	56.00	7.48																				
60	29.86	5.46	37.80	6.14	46.66	6.83																				
70	25.60	5.06	32.40	5.69	40.00	6.32	48.40	6.95	57.60	7.58	67.60	8.22	76.98	8.77												
80	22.40	4.74	28.35	5.32	35.00	5.91	42.35	6.50	50.40	7.10	59.15	7.68	67.35	8.20												
90	19.92	4.46	25.20	5.02	31.11	5.57	37.64	6.13	44.80	6.69	52.58	7.25	59.86	7.73												
100	17.92	4.23	22.68	4.76	28.00	5.29	33.88	5.82	40.32	6.35	47.32	6.87	53.88	7.34	67.50	8.21	76.80	8.76	86.70	9.31	97.20	9.86	120.	10.95	145.	12.04
110	16.29	4.03	20.62	4.54	25.46	5.04	30.80	5.55	36.66	6.05	43.00	6.55	48.98	6.99	61.87	7.83	69.82	8.35	78.82	8.87	88.36	9.40	109.	10.44	132.	11.49
115	15.59	3.95	19.72	4.44	24.35	4.93	29.46	5.42	35.07	5.92	41.15	6.41	46.85	6.84	58.69	7.66	66.79	8.17	75.40	8.68	84.53	9.19	105.	10.24	126.	11.23
120	14.94	3.86	18.90	4.34	23.34	4.83	28.23	5.31	33.60	5.79	39.44	6.28	44.83	6.69	56.25	7.50	64.00	8.00	72.25	8.50	81.00	9.00	100.	10.00	122.	11.00
125	14.33	3.78	18.14	4.26	22.40	4.73	27.10	5.20	32.26	5.68	37.86	6.15	43.11	6.56	54.00	7.34	61.44	7.83	69.36	8.32	77.75	8.81	96.00	9.79	116.	10.77
130					21.54	4.64	26.06	5.10	31.02	5.57	36.40	6.03	41.45	6.43	51.92	7.20	59.08	7.68	66.70	8.16	74.77	8.64	92.00	9.59	112.	10.58
140					20.00	4.47	24.20	4.92	28.80	5.36	33.80	5.81	38.49	6.20	48.22	6.94	54.86	7.40	61.93	7.87	69.43	8.33	86.00	9.27	104.	10.19
150					18.66	4.32	22.58	4.75	26.88	5.18	31.54	5.61	35.92	5.99	45.00	6.70	51.21	7.15	57.80	7.60	64.80	8.05	80.00	8.94	97.00	9.85
160									25.20	5.02	29.56	5.43	33.68	5.80	42.19	6.49	48.00	6.93	54.19	7.36	60.75	7.79	75.00	8.66	90.00	9.52
170									23.72	4.87	27.83	5.27	31.70	5.63	39.71	6.30	45.18	6.72	51.00	7.14	57.18	7.56	71.00	8.42	85.00	9.22
180													29.94	5.47	37.50	6.12	42.66	6.53	48.17	6.94	54.00	7.35	67.00	8.17	81.00	9.00
190													28.36	5.32	35.53	5.96	40.43	6.36	45.64	6.75	51.16	7.15	63.00	7.93	76.00	8.71
200													26.94	5.19	33.75	5.81	38.40	6.19	43.35	6.58	48.60	6.97	60.00	7.74	72.00	8.47

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Coaling a Liner at Nagasaki

Although the coaling of the large transatlantic liners in New York harbor is carried out by machinery and over 8,000 tons of coal have been placed in a ship's bunkers in nineteen hours, nevertheless the coaling of a liner at Nagasaki, Japan, is quite a different matter, as the work



Bunkering the *Shinyo Maru* at Nagasaki—3,500 Tons of Coal Taken on Board in Twenty-four Hours

is done entirely by hand, as shown in the accompanying photograph. This photograph was taken from the deck of the Japanese liner *Shinyo Maru,* of 13,384 gross tons, while coal was being taken on board at the rate of 3,500 tons in 24 hours, and gives an excellent idea of the great number of men required for transferring the coal from the small barges alongside to the ship's bunkers.

Manila, P. I. C. N. CONOVER,
Chief engineer, U. S. Coast and Geodetic Survey.

Checking Up the Coal Consumption

While every item of expense in the operation of a line of steamers is no doubt closely scrutinized by the general manager, perhaps that of coal receives the closest attention of any, because it is the biggest single item of expense incurred. I found on taking charge of the engine room of a bay steamer that a daily report of the coal consumed was required to be turned in to the office at the end of each round trip. This was something of a problem, for we had no accurate means for determining just what that was. Of course we knew about what the average per day was by the amount of coal delivered to us. This was calculated at the end of each month, the total consumption being divided by the number of days in the month. But this did not tell us what we did from day to day with varying conditions, and naturally it was impracticable to go into the bunker with a tape line and measure it up every morning. Sometimes if the coal bills were "up" we even felt that perhaps the weights were short. To have the coal weighed in the cars at the yard costs one dollar (4/2) a car, and, unless so weighed it was sold to us by the mine weight, and, as the mines were more than three hundred miles away, some of us received these figures with a mental reservation. The coal was wheeled aboard in barrows, and the barrows always counted and occasionally weighed, but this did not satisfy us entirely, and, besides, we wanted to get at the consumption from day to day, as stated above, and how it changed with varying conditions, the run being the same distance every night—about two hundred miles.

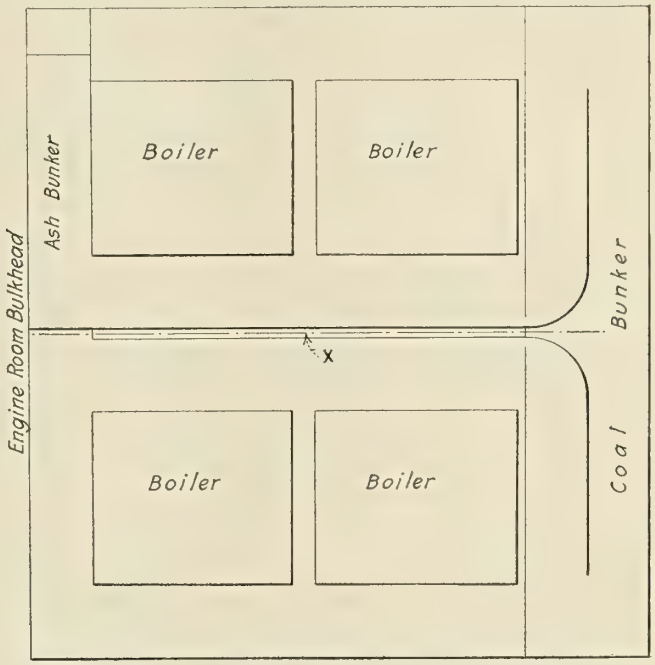


Fig. 1.—Diagram of Boiler Room, Showing Location of Trolley and Tripping Device

It had been customary for years to count the buckets of coal as brought out of the bunker, and this was what had been recorded on the daily report. These reports were seldom anywhere near the coal bill at the end of the month. For one reason it depended on a coal passer marking up

each bucket as it was brought out of the bunker. Of course, sometimes he marked it up, and sometimes he forgot it, and, for another reason, the location of the bunker door was such that the forward boilers could be fired directly with the coal that ran out on the floor when the bunker was filled. This latter was supposed to be accounted for by marking up a bucket for so many shovels. The result was that the count was so erratic as to be not worth recording. The chief engineer of our sister boat hit on a scheme for recording the count of buckets automatically with a register such as is used on street cars. A device was placed over the bunker door in such a way as to engage the trolley as it came out of the bunker and automatically pulled a wire that operated the register placed in the engine room. This arrangement proved unsatisfactory because the bunker had to be empty enough

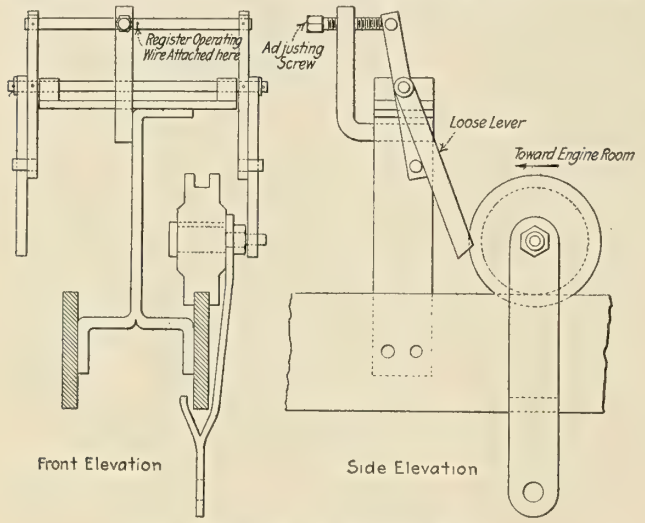


Fig. 2.—Sketch of Tripping Gear

to allow the bucket to enter the door or it would not work automatically, and had to be rung up by hand by the coal passer till considerable coal had been used, and of course it did not account for the coal on the fire-room floor that ran down to the forward boilers, as explained above, so that had to be counted as before.

While this arrangement was unsatisfactory, it rather tended to make the situation more acute, because it was presumed to be more accurate. After this had been tried and found wanting, it occurred to me that a much better scheme would be to install just such an arrangement as this, but to put the tripping gear over the track in the middle of the fire-room, and only to take account of the coal going to the after boilers. Assuming that all the boilers would consume about the same amount, the total used could be estimated to a very close approximation. As the coal could not very well be gotten to the after boilers except by the bucket, this arrangement was bound to work out pretty close in practice unless someone deliberately set about trying to fake the count, which is, of course, most unlikely.

The results were surprising, and also surprisingly accurate. The situation was immediately cleared up and there was no further argument as to whether we did or did not burn the coal. We are now accumulating some very interesting data. Our longest run without a stop is approximately 175 miles, and, running with the tide, we make around 56,000 revolutions at 85 or 86 revolutions per minute, and, running against the tide, we make around 65,000 to 66,000 revolutions at about 100 revolutions per minute. We have about eleven hours in which to make this run, and the difference in coal consumption between fair and adverse conditions not infrequently exceeds 75 percent. The sketches will enable anyone interested to install some similar arrangement, and, take it from me, a constant and reliable check on the coal consumption is a revelation to the uninitiated and, incidentally, it seems to be some satisfaction to the general manager.

Norfolk, Va. D. SAWYER,
Chief Engineer, steamship *Northland,* Norfolk and Washington Steamboat Company.

Indicator Test of Triple Expansion Marine Engine

As part of some thesis work at the Georgia School of Technology a test was run on the main engine of the steamship *City of St. Louis,* which is one of a fleet of coastwise steamers owned by the Ocean Steamship Company, plying between Savannah, Ga., and New York City.

The *City of St. Louis* is a combination freight and passenger steamer and a first class boat. She is 397 feet 9 inches in length, and measures 49 feet 6 inches at greatest width of beam. Two hundred and twenty passengers, including first and second class passage, can be comfortably accommodated, and her gross tonnage is 6,200. She was built by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., during 1909-10, being launched in June of 1910.

She is equipped with four Scotch boilers, 14¾ feet in diameter, 11½ feet long, each having 280 stay tubes 3¼ inches in diameter, 7 feet long, and a heating surface of 8,500 square feet. The shells of the boilers are made of soft boiler plate steel 1¼ inches thick, having a tensile strength of 65,000 pounds per square inch. A double lap plate butt joint is used and the rivets are 1¼ inches in diameter, which gives 81 percent efficiency for the joint. These boilers have an allowable pressure of 180 pounds per square inch, but were tested when installed to 240 pounds per square inch, hydrostatic pressure.

A smokestack 8 feet in diameter and 60 feet long furnishes a natural draft for the boilers, which steamed well save at times, when the wind was from her stern.

Steam is conveyed from the boilers to the high-pressure cylinder through a 10-inch steel pipe, well lagged with a composition of asbestos and magnesia, and covered with polished thin sheets of steel.

In addition to these boilers, one donkey boiler is installed for use in case of emergency.

These boilers are supplied with water, from the hot well and feed water heater, through two pumps; also two injectors which are brought into play only when the steamship is in fresh water.

THE ENGINE

The main engine is of the vertical, triple expansion, condensing, marine type. The high-, intermediate- and low-pressure cylinders are 26 inches, 43 inches and 72 inches in diameter, respectively, with a common piston stroke of 4 feet. The cranks are set 120 degrees apart, operating in this sequence, high-pressure, intermediate-pressure and low-pressure. The steam from the low-pressure cylinder is discharged into a surface condenser through which sea water is circulated by a centrifugal pump.

The ratios of the volumes of the cylinders and receivers is as follows: high-pressure cylinder as unity, intermediate-pressure receiver 3, intermediate-pressure cylinder 2.75, low-pressure receiver 10.4, low-pressure cylinder 7.75.

Single-ported, balanced piston valves were used to control the admission of steam to the cylinders: one 12-inch valve for the high-pressure cylinder, two 12-inch valves for the intermediate-pressure cylinder and two 25-inch valves for the low-pressure cylinder, all having the same travel, viz., 7 inches, and controlled by the same type of valve mechanism, namely, the standard Stevenson link motion. The high-pressure valves take steam on the inside edge, while the intermediate-pressure and low-pressure valves take steam on the outside edge.

The crankshaft is 14 inches in diameter, supported by six babbit bearings 20 inches long, each being water cooled.

The piston is connected to the crosshead by a rod 6 inches in diameter. The crosshead reciprocates between two guides 30 inches apart and 20 inches wide, being 56 inches in length. Each is made of white babbit metal, water cooled and pitted over its surface to facilitate better lubrication.

The propeller is four-bladed, 16 feet in diameter, with a pitch of 19½ feet. The propeller shaft is 13⅞ inches in diameter, 106 feet long, made in four sections, supported every 20 feet by well-designed, water-cooled, babbit bearings. The shaft in each ran in a bath of oil, and showed no evidences of heating.

In addition to the main engine, there were in the engine room two 10-inch by 12-inch Westinghouse automatic engines, coupled directly to generators for developing electric current for lights and supplying the wireless apparatus. Among other apparatus in the engine room, besides the steam steering gear, was a common surface condenser, 5 feet in diameter and 11½ feet long, having about 4,000 square feet of condensing surface. The air pump connected to it was driven by a walking beam from the low-pressure crosshead. A centrifugal pump, two direct-acting steam pumps, a fire and sanitary pump, comprised the rest of the engine room equipment.

The Test

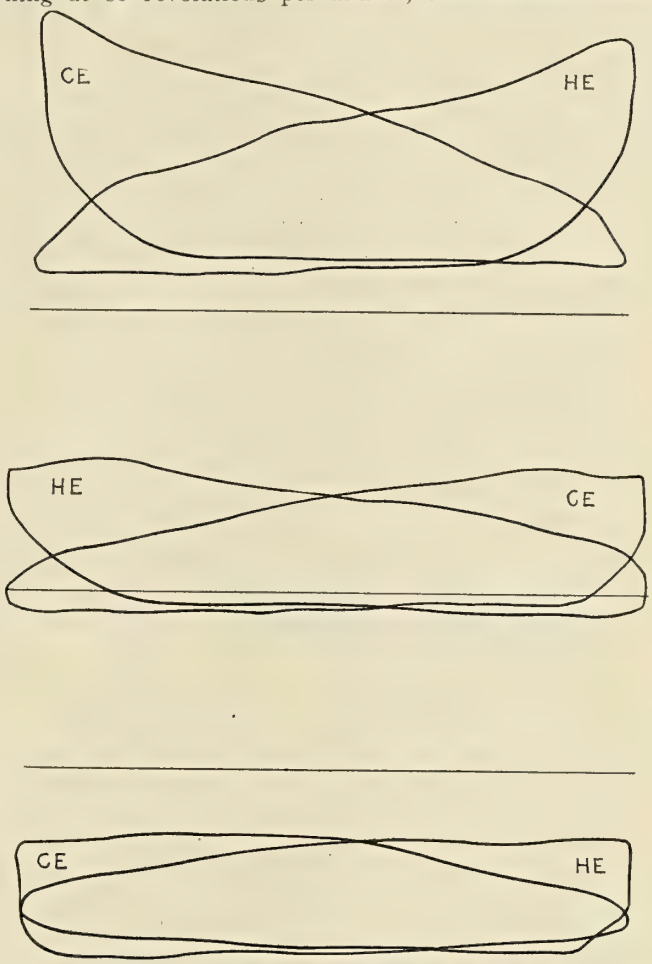
The test data were obtained during a voyage between the ports of Savannah, Ga., and New York City and return, from April 14 to 20, 1914. Thompson indicators were attached to the cylinders and cards taken from each end of each cylinder every half hour during six hours each day. Each time a card was taken, readings were made of the revolutions per minute, pressures of the boiler, intermediate-pressure and low-pressure receivers, vacuum, and the distance the ship had gone by the log during that period. From these data calculations were made of the mean effective pressure, indicated horsepower, end thrust and steam consumption.

The set of indicator cards reproduced on this page were taken with a boiler pressure of 152 pounds gage and an intermediate receiver pressure of 23 pounds gage, and a low-pressure receiver of 1.5 pounds gage. The vacuum was 28 inches, the barometer reading 29.7 inches, and the engine was turning at the rate of 67.3 revolutions per minute.

Taking first the high-pressure card, the mean effective pressure of the head end is found to be 61.3 pounds and the indicated horsepower 265.48. The mean effective pressure of the crank end of the high-pressure cylinder is 65 pounds, and the indicated horsepower 266.51. Next, taking the intermediate-pressure cylinder, the mean effective pressure of the head end is 18 pounds and the indicator horsepower 213.21. The mean effective pressure of the crank end is 17.6 pounds and the indicated horsepower 204.41. From the low-pressure card it is found that the mean effective pressure of the head end is 6.4 pounds and the indicated horsepower 212.59, while the mean effective pressure of the crank end is 6.8 pounds and the indicated horsepower 224.31.

The total indicated horsepower developed by the engine at 67.3 revolutions per minute, as computed from these cards is, therefore, 1,386.51.

From the observed data recorded the lowest number of revolutions was 61.8 and the highest 80. At 61.8 revolutions per minute the engine developed 1,219.57 indicated horsepower. The pounds of steam used per hour was 15,276.96, the number of pounds steam used per revolution 4.12, and the number of pounds of steam used per indicated horsepower per hour 12.5. With the engine running at 80 revolutions per minute, the indicated horsepower developed was 2,843.95, the number of pounds of steam used per hour 30,816, the number of pounds used per revolution 6.42, and the number of pounds steam used per indicated horsepower per hour 10.8. The propeller thrust varied from 16.82 tons with the engine running at 61.8 revolutions per minute to 35.55 tons with the engine running at 80 revolutions per minute.



Set of Indicator Cards from Main Engine of *City of St. Louis*

In making the trip from Savannah to New York, the engines were run at slower speed, the boiler pressure averaged 150 pounds, and the point of cut-off in the high-pressure cylinder was made about .5 of the stroke, while on the return trip the engines ran faster, the boiler pressure was higher, and the cut-off lengthened out to about .7 of the stroke. In consequence of which we made the return trip in several hours' less time. I was told that the reason for varying the speed in the two trips is due to the fact that the boat can put into port at New York only at specified times, whereas they can go into Savannah at any time. The higher speeds are accomplished at

the expense of the boilers and a greater coal consumption, but upon the assumption that the cost of propelling this steamer varies as the cube of her speed, and that the overhead expenses are $100 (20/16/8) per hour, we have worked out a problem to show the most economical speed, under the conditions, at which she could be run.

When the speed is 10 miles per hour, the cost is $25 (5/4/2) per hour. Therefore let

Let C = cost
K = constant
X = her most economical speed
M = the distance traveled
$C \propto X^3$
$C = KX^3$
$25 = (10)^3 K$

$$K = \frac{1}{40}$$

$$C = \frac{M}{X} \cdot \frac{X^3}{40} + \frac{M}{X} \cdot 100 = M\left[\frac{X^2}{40} + \frac{100}{X}\right]$$

Differentiating, we have,

$$\frac{DC}{DX} = \frac{2X}{40} - \frac{100}{X^2} = 0$$

Equating to zero and solving for X, gives

$$2X^3 = 4{,}000$$
$$X = 12.6 \text{ miles per hour.}$$

Discussion

The cards from this engine show it to be working under very good conditions. The work on the head and crank ends of the cylinders is well proportioned, while the same may be said of the work done by each cylinder. The steam consumption per indicated horsepower per hour averages 11.9 pounds, which speaks well for its economy. Its ideal thermal efficiency is 32.1 percent, which is high for an engine subjected to varying loads. The actual thermal efficiency is 21 percent, which, too, is all that could be expected of it.

There is but one defect so far as I could discover, and it is so slight that I doubt if it materially affects its economy. The lead on the head end of the intermediate-pressure cylinder is a little early. This is shown on the card by a little loop on the admission corner of diagram.

$\frac{T' - T''}{T'}$ is the ideal thermal efficiency of an engine expanding to back pressure. Where T' is the absolute temperature corresponding to the pressure at which it receives steam, T'' is absolute temperature corresponding to the pressure at which the steam leaves the cylinder (back pressure).

Temperature corresponding to 150 pounds gage + 461 = 826.9 degrees absolute.
Temperature corresponding to 175 pounds gage + 461 = 838.4 degrees absolute.
Temperature corresponding to vacuum 27.5 inches = 569 degrees absolute.

$$\text{Maximum ideal efficiency} = \frac{826.9 - 569}{826.9} = 31.2 \text{ percent at 150 pounds gage.}$$

$$\frac{838.4 - 569}{838.4} = 32 \text{ percent at 175 pounds gage.}$$

Actual Thermal Efficiency

Total heat in steam at 150 pounds gage from 32 degrees F. = 1,193.6 B. T. U.
Total heat in steam at 175 pounds gage from 32 degrees F. = 1,197.1 B. T. U.
Consumption in pounds per indicated horsepower per hour = 11.9 pounds.
Feed water heated to 210 degrees F.
$210 \times 32 = 178$ B. T. U. in feed water.
1,193.6 — 178 = 1,015.6 B. T. U. heat actually in the steam.
1,197.6 — 178 = 1,019.1 B. T. U. heat actually in the steam.
One horsepower = 33,000 foot pounds per minute.
One horsepower uses $1{,}015.6 \times 11.9 = 121{,}000$ B. T. U. per hour.

$$\frac{990{,}000 \times 60}{778} = 2{,}545 \text{ B. T. U. per hour.}$$

$$\frac{2{,}545}{121{,}000} = 21 \text{ percent efficiency at 150 pounds gage.}$$

ALFRED CHINA DE LORME.

Removing a Piston from its Rod

A certain lake steamer which had been in service several years was docked in the fall for general overhauling. One of the jobs that seemed necessary was to re-turn the piston rod, which had become scored badly from the use of poor grades of packing. The intention was to turn it down smooth in a lathe and fit a good type of metallic packing.

The cylinder head was removed, the junk ring and packing rings removed and the nut on the end of the rod backed off, but when it came to remove the piston from the rod with a good sized chain hoist it was found impossible to separate them.

The piston rod was coned 1 to 6 at the top end and 1 to 3½ at the bottom, so it was an easy matter to remove the rod from the crosshead, as it did not stick tightly, and so both rod and piston were taken to the shop together. But the lathe would not take the rod with so large a piston on it, so one of the shop mechanics suggested the following simple scheme.

A piece of pipe whose inside diameter was greater than the shaft's diameter was obtained and cut off in a length equal to the distance between the piston and the crosshead nut when partially hove-up. This was slipped on over the piston rod, then an old flange for a washer, and then the crosshead nut was screwed up, thus pressing the pipe tight against the piston. The pipe was then heated by means of a blow torch, and the expansion of the material due to the heating created enough pressure to break the grip between the rod and piston, whence they could be easily removed. N.

Opportunity for Export of American Machinery and Supplies to Russia

The Russian Society for Electrical Enterprises, Ltd., 5 Marsowo Polje, Petrograd, Russia, writes to INTERNATIONAL MARINE ENGINEERING to state that the Society is opening branches in various parts of the Russian Empire, and that it wishes to make arrangements to represent American manufacturers of electrical machines and appliances of all kinds, steam engines and steam specialties, internal combustion engines, etc. Catalogues and other information should be sent direct to the Society.

LAUNCH OF LAKE OIL TANKER.—The Collingwood Shipbuilding Company, Ltd., Collingwood, Ont., recently launched the steamer *Royalite* for the Imperial Oil Company, Ltd. The vessel is the first of three sister ships being built by the Collingwood Shipbuilding Company for the Imperial Oil Company. They will be employed in the oil-carrying trade on the lakes, but are to have all necessary equipment for ocean service. The steamer's dimensions are 258 feet overall, 43 feet beam and 18 feet molded depth. Her equipment is of the most up-to-date description.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Method of Testing a Gasoline Petrol Engine

Q.—When a gasoline (petrol) engine is tested on the blocks previous to its acceptance, is there any customary procedure followed in making the tests—i. e., there are tests run at varying revolutions per minute and load, and what I want to know is how these varying conditions are arrived at. There seem so many variables, as spark, throttle, brake, etc., that some are undoubtedly kept in a constant given condition. If you would outline the steps for a complete test I should greatly appreciate it. G. E.

A.—Gasoline (petrol) engines, in general, operate under two conditions of loading: (A) When the speed is maintained constant and the load may vary, as is the case when connected to electric generators, and (B) they may operate under conditions of varying speed and varying load when the load is a function of the speed, as is the case when installed in a motor boat. Complete tests should investigate both conditions, and the best procedure is as follows:

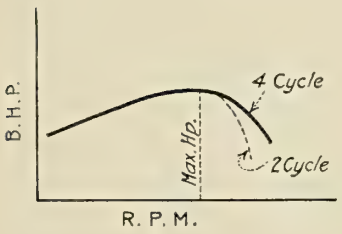


Fig. 1

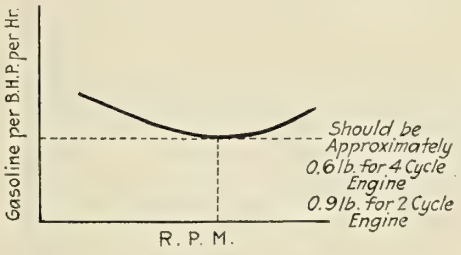


Fig. 2

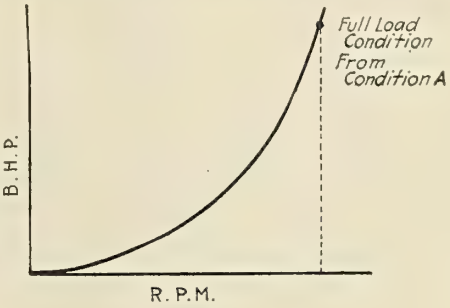


Fig. 3

Condition A. (Constant speed.) To determine the best speed, operate the engine with wide open throttle and best spark at all speeds up to no load or racing speed, and obtain curve of Fig. 1. For the individual runs set the throttle wide open and adjust the spark at each speed. Obtain speed variation by varying the brake load. At the same time derive the fuel consumption curve as shown in Fig. 2. The maximum and minimum of these curves occur at the revolutions per minute which are the best revolutions per minute for the engine to operate at when operating at full power.

Passing now to condition B, when the engine is to be used in a motor boat. Decide from the above curves the best revolutions per minute and select or design a propeller to hold the motor to not more than this speed with wide open throttle, then plot the curve of probable horsepower on revolutions per minute for the hull. This curve will be of the order H. P. = K $\times$ (R. P. M.)^3, so that if the full load condition be taken from (A) condition runs, the other points can be determined by making the horsepower vary as the cube of the R. P. M.—that is, at ½ R. P. M. (which is nearly ½ speed) the horsepower would be $(\frac{1}{2})^3 = \frac{1}{8}$ of the maximum.

Then in testing the motor at fractional speeds, select the horsepower and revolutions per minute from this curve. Get the speed (R. P. M.) by means of the throttle and adjust the brake to give the horsepower in accordance with the curve of Fig. 3.

Highest Steam Pressure Recorded—Velocity of Flow of Steam

Q.—Will you please answer the following questions in your next issue: (1) What is the highest steam pressure that can be generated? (2) What is the velocity of steam at one pound gage pressure flowing into a vacuum of 29 inches? What is it at 200 pounds gage flowing into the atmosphere, and how may it be calculated? N. P.

A.—(1) The highest steam pressure which has been reported is a pressure of 3,200 pounds per square inch at a temperature of 706.1 degrees F. This was reported by Holborn and Bauman in 1910 (*Annalen der Physik*, 1910) and is given by them as the pressure and temperature corresponding to the critical state of saturated steam. This has been accepted by authorities as being reliable, and is probably the highest pressure which has been actually obtained in a vessel containing steam.

(2) Adiabatic expansion of saturated steam in a properly designed nozzle (assuming no frictional losses) from 1 pound gage to 29 inches vacuum would give a velocity of 3,240 feet per second, assuming the barometer to be at 30 inches. Similar expansion from 200 pounds gage to atmosphere would give 3,120 feet per second.

The calculations are made as follows:

$$V = 224\sqrt{H_1 - H_2}$$

where V = velocity in feet per second
H_1 = heat contents of steam at upper pressure
H_2 = heat contents of steam at lower pressure

The heat contents H_1 for the first case is found from any good temperature entropy diagram or table as 1,150 B. T. U. That for the lower pressure and same entropy is 943 B. T. U. Therefore

$V = 224\sqrt{1{,}150 - 943} = 224 \times 14.48 = 3{,}240$ feet per second.

And similarly for the second case

$H_1 = 1{,}197$
$H_2 = 1{,}003$
$H_1 - H_2 = 194$
$V = 224 \times 13.93 = 3{,}120$ feet per second.

Calculations of this sort are best made by aid of the Mollier diagram, which is a diagram of total heats (heat

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

contents) plotted on entropies. This diagram accompanies most of the modern tables of properties of saturated steam. In the above formulas, $224 = \sqrt{2g \times 778}$.

Number of "Live" or Effective Coils in a Spring

Q.—I shall now be exceedingly obliged if you will show by diagram the number of "live" or effective coils in any spring; how to count them correctly. X.

A.—Begin at that part of the coil which is unreduced in section, as *A*, Fig. 1, jump to the corresponding part of the next coil, as *B*, and so on successively down the spring till there is but a fraction of a complete jump remaining,

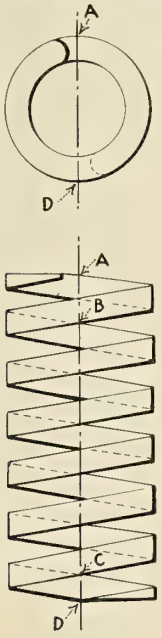


Fig. 1

as *C* in Fig. 1. Then estimate the fractional part of a complete coil remaining, as *C-D* and add it to the complete coils counted. If the ends of the spring are of less pitch as well as tapered, judgment is your only guide as to how much of a coil they are to count for. Obviously, if any two coils touch, all coils from the point of contact on are dead and should not enter into the calculation.

Percentage of CO_2 in Flue Gases for Good Operation

Q.—What should be the percent of CO_2 in flue gases for good operation at sea? Is 9 percent good, and if not can you tell me whether the efficiency of the boiler would be improved if I had a larger percentage and about how much? Fireman.

A.—Nine percent is lower than should be obtained with good fuel and firing. The values commonly met with range from 8 percent, which is considered poor, to 12 percent, which is considered good. If with 12 percent CO_2 the boiler efficiency is 67 percent, it will be about *

66½ percent for 11 percent CO_2
66 percent for 10 percent CO_2
64 percent for 9 percent CO_2
60 percent for 8 percent CO_2

It is obvious that increasing CO_2 from 11 percent to 12 percent effects much less gain in efficiency than increasing it from 8 percent to 9 percent.

* Lucke, "Handbook of Thermodynamics."

Shipbuilding Boom in China.—Hong Kong is enjoying a shipbuilding boom on an extensive and unprecedented scale. At the Taikoo yard every slip is full, the work on hand consisting of six new ships. The Taikoo yard is now so equipped that it is able to deal with all classes of vessels up to 10,000 tons, and, in view of the conditions existing in Europe, the company expects many more orders for new ships.

NEW BOOKS FOR MARINE ENGINEERS

Design of Steam Boilers and Pressure Vessels. By George B. Haven, S. B., and George W. Swett, S. B. Size, 5¾ by 9 inches. Pages, 416. Illustrations, 197. New York, 1915: John Wiley & Sons, Inc. Price, $3 net.

In writing this book, the aim of the authors, who are professors of machine design at the Massachusetts Institute of Technology, has been, as stated in the preface, to give the most practical procedure possible in the design of boilers and other pressure apparatus.

Wherever possible results have been obtained by rational rather than empirical methods. The usages of current boiler-making practice have been kept constantly in view. In the application of the principles and formulæ deduced in the early chapters of the book to the practical design of various types of boilers and pressure vessels, the data and constants assumed are derived from actual practice and represent wide margins of safety in regard to boiler performance and construction.

In discussing the general principles of boiler design, the authors take up types of boilers, circulation, materials, the factor of safety, thermal efficiency, boiler horsepower, size of units, range of pressure, superheaters, fuel, grates and settings, and a summary is given which well represents the requirements of modern practice.

Chapter II contains a mathematical discussion of the stresses in pressure vessels, and gives practical rules and formulæ by means of which such problems are solved in actual practice. Chapter III is a very complete discussion of the subject of riveted joints and is splendidly illustrated, not only by diagrams of the various joints with an explanation of the calculations for efficiency and strength, but also by numerous diagrams and tables which give the volume of rivet heads, the allowance for rivet heads, rivet strength and maximum value of pitch and efficiency of various joints. Chapter IV is on general proportions of boilers, and here the data are based on actual practice and are presented in most convenient form, frequently by tables and plots.

The remaining five chapters illustrate the application of the principles and formulæ to the practical design of various types of boilers and pressure vessels. Chapters V, VI, VII and VIII give complete specifications and calculations for the design of a horizontal return tubular boiler, a dry back Scotch boiler with combustion chamber in shell extension, a vertical straight shell multitubular boiler and a locomotive type boiler for contractors' use. The final chapter is on tank design. To illustrate the problems in design, large plates are shown, giving the complete drawings.

How to Save a Big Ship From Sinking. By Charles V. A. Eley. Size, 5 by 7¼ inches. Pages, 195. Numerous illustrations. London, 1915. Simpkin, Marshall, Hamilton, Kent & Co., Ltd. Price, 3/6 net.

Dealing with the salving of a vessel, either in preventing its sinking or after it has sunk by collision or mine or torpedo attack, as a strictly engineering problem, the author suggests an installation of salvage pumps capable of utilizing the whole of the power existing in the ship for propulsion for expelling water from the vessel. The best kind of pump to use for the work he considers would be the involute centrifugal single stage type, although in certain cases the expulsor form of steam pump, or even steam jet pumps, might be considered. Estimates of the probable additional weight and cost of such installations point, in the author's opinion, to the feasibility of such a system.

Marine Articles in the Engineering Press

Heat Losses—Improved Steering Gear—Stability—New Vessels —Model Experiments—Alternative Methods of Propulsion

Heat Losses in Steam Transmission.—By W. L. Cathcart. This article discusses mathematically the transmission of heat from one body to another by radiation and conduction and gives Péclet's formulæ for heat losses due to radiation and conduction. By means of the formulæ thus reviewed, the heat losses of uncovered and covered pipes are compared for both saturated and superheated steam. 2 illustrations. 10,000 words.—*Journal of the American Society of Naval Engineers,* August.

Improvement of Screw Steering Gear.—The author in the comparison of a usual screw steering gear with his proposed reversed tiller gear points out how the first in its way from center position to hard over has a more uniform angular velocity, a smaller moment up to the end and a more steadily increasing power demand than the proposed arrangement which in the hard over position has a very large effective leverage with decreased angular velocity and a small power demand. The author comes to the conclusion that a smaller steering engine could furnish improved steering capacity in the proposed arrangement. The article takes note also of the German experiments on the greatly increased rudder pressures, when the rudder is laid from hard over to hard over. 7 illustrations. 3,400 words.—*Schiffbau,* October 27.

A Method of Estimating the Stability Required by a Ship.—By Arthur R. Liddell. Owing to the fact that there is a current belief that the stability of a ship is an intangible quality that is in itself a mystery, the author attempts to show a matter-of-fact way of dealing with the subject so that various factors affecting stability will be more clearly understood. A table is given which embodies a method of quickly obtaining the metacentric height corresponding with an ordinate of the curve of moments at 30 degrees equal to zero. To obtain the metacentric height corresponding with the ordinate of the curve of moments for the inclination of 30 degrees, the decimal value from the table is multiplied by the breadth of the ship and the result is then added to twice the length of the lever corresponding with the ordinate of the moment curve at 30 degrees. To enable stability to be properly dealt with, the author maintains that some recognized authority should take it up. A committee or central office should be formed, the functions of which should be the collection of material, the analyzing of cases of accident and the gradual establishment of a body of natural laws and conditions on the basis of which professional judgment could be confidently founded. In view of the mass of knowledge thus accumulated, stability would cease to be the mystery that it now is. 1 illustration. 2,200 words.—*The Engineer,* November 5.

Torpedo Boat Destroyer Ericcson.—By W. H. A. Lange. The United States destroyer *Ericcson,* authorized by Congress August 22, 1912, was built by the New York Shipbuilding Company, Camden, N. J., to the following dimensions: Length overall, 305 feet 3 inches; beam on load waterline, 30 feet 6 inches; mean draft, 9 feet 9 inches; normal displacement, 1,090 tons. Propulsion is by two shafts actuated by turbines of 17,000 shaft horsepower, which at 600 revolutions per minute drive the ship at a speed of 29 knots. The machinery arrangement is starboard shaft, main high-pressure turbine, independent astern turbine; port shaft, low-pressure turbine combined with astern turbine. Coupled forward of the low-pressure turbine is a vertical direct-acting compound reciprocating engine, 16 by 24 by 18 inches stroke connected to the turbine shaft by a Metten hydraulic clutch. The reciprocating engine is used for cruising speeds up to 12½ or 16 knots. Steam is supplied at 265 pounds pressure by four Thornycroft oil-burning boilers with a total heating surface of 23,936. The propellers are three-bladed, 91½ inches diameter by 78 inches pitch with a projected area of each propeller of 4,024 square inches and a developed area of 4,500 square inches. On the standardization trials a speed of 29.33 knots was attained with the propellers turning at 616.98 revolutions per minute and the engines developing 17,796 shaft horsepower. On the four-hour full power trial the speed was 29.29 knots and the water consumption of all machinery per shaft horsepower main engines was 15.762 pounds. The fuel oil consumption was 1.23 pounds per shaft horsepower per hour and the water evaporated per pound of oil per hour was 12.818 pounds. 3 illustrations. 3,400 words.—*Journal of the American Society of Naval Engineers,* August.

The Cylindrical Tank Oil-Carrying Steamers Breifond and Aztec.—One of the recent developments of a more or less important nature in the construction of vessels for carrying oil in bulk at sea is the method employed in the cylindrical tank oil-carrying steamers *Breifond* and *Aztec.* On account of the fact that a cylindrical form will withstand more pressure than a form composed of flat surfaces of equal scantling, this fundamental principle has been adapted to the requirements of the bulk-oil trade in these two vessels by fitting the carrying space with large cylindrical retainers in which the oil is carried, instead of in ordinary holds with straight bulkheads. Both vessels were built and engined by Messrs. William Doxford & Sons, of Sunderland. They are sister ships of the following dimensions: Length overall, 400 feet; length between perpendiculars, 390 feet; breadth extreme, 53 feet; depth, molded, 32 feet 9 inches; draft, load, 25 feet 6 inches; gross tonnage, 5,711; net tonnage, 2,353; deadweight capacity, tons, 8,500; displacement, tons, 11,550. One continuous deck extends the full length of the ship. The forepeak is constructed for the storage of oils, and immediately aft of the forepeak are fitted six cylindrical tanks, above which is an expansion trunk. Light, refined oils may be carried in the circular tanks, the double bottom and the spaces outside the cylinders, but, in order to facilitate cleaning, the dirty oils are carried in the cylinders only. Space between cylindrical tanks Nos. 4 and 5 is utilized for the cargo pump room, while aft of No. 6 tank is a cross bunker hold. The crew is quartered in the forecastle, the captain and officers in a deckhouse amidships, and the engineers in the poop. Propulsion is by a single set of triple-expansion engines with cylinders 21½, 44 and 74 inches diameter by 48 inches stroke, supplied with steam by two four-furnace Scotch boilers working under Howden's forced-draft and arranged for burning either oil or coal. The machinery is situated aft. The pumping plant consists of two large duplex horizontal pumps, each capable of discharging 400 tons of oil per hour. Connection is made to all the tanks of the ship, including the double bottom, the same machinery dis-

charging the water ballast, as well as the oil cargo. 6 illustrations. 2,000 words.—*The Shipbuilder,* October.

Notes on Model Experiments.—By G. S. Baker, superintendent of the William Froude National Tank. The paper gives an account of some of the work done in the William Froude National Tank during the last two or three years, showing the mode of carrying out the experiments and the application of tank work to ships and the actual reductions of power effected in a number of cases. The work is dealt with under three headings—skin friction resistance, strut and bilge keel resistance, and the effect of hollow and straight ends. In the first section a new analysis of the previous work is given, together with the results of further experiments on friction and the skin friction resistance for all lengths of planks, is reduced to a simple form and plotted as a single curve from which ship resistance can be rapidly calculated. The effect of temperature upon the frictional resistance of a model is dealt with. An account is given of some experiments to determine the increase in resistance due to plate edges and butts, and the results are compared with W. & R. E. Froude's work. The second section deals mainly with the effect of size on strut resistance, and incidentally the applicability of model appendage experiments to the full-size ship. It also deals with the effect of fore-and-aft position of bilge keel on its resistance. The third section contains an analysis of a very complete set of experiments on hollow and straight lines and shows the limits of usefulness of either form and how these limits depend upon the prismatic coefficient and the speed. 4 plates. 5 illustrations. 11,000 words.—*Transactions of the North-East Coast Institution of Engineers and Shipbuilders,* December.

Some Alternative Designs of Propelling Machinery for a 19¼-Knot Steamer.—By James Dornan. In order to compare various systems of propulsion as regards power, efficiencies, coal consumption, weights and annual savings effected, the design of a 19¼-knot steamer of 21,000 tons displacement on a draft of 27 feet was chosen and the comparisons worked out based on data from the actual performance of similar ships. The vessel chosen was 600 feet long, 72-feet beam and 46-feet depth, of 10,000 net registered tons, an intermediate passenger and cargo type usually engaged in the North Atlantic trade. Seven designs were compared, namely: Two-shaft, quadruple-expansion engines using saturated steam; four-shaft, direct turbine drive with saturated steam; two-shaft, quadruple-expansion engines with superheated steam; four-shaft, direct turbine drive with superheated steam; two-shaft hydraulic geared transmission with superheated steam; two-shaft geared turbine drive with superheated steam, and a two-shaft turbo electric geared drive. As compared with the first design (two-shaft quadruple engines with saturated steam) the various other designs showed increased economy in coal consumption varying from 5 percent for the four-shaft direct turbine drive with saturated steam up to 35 percent for the two-shaft turbo electric gear. The most important figures presented in the paper, however, are those for the net annual return on cost in percent. These were as follows: Two-shaft, quadruple-expansion engines with saturated steam, 7 percent; four-shaft, direct turbine drive with saturated steam, 9½ percent; two-shaft quadruple engines with superheated steam, 9 percent; four-shaft, direct turbine drive with superheated steam, 10 percent; two-shaft turbines with hydraulic gear, 12¼ percent; two-shaft, geared turbine drive with superheated steam, 11¾ percent, and two-shaft, turbo electric geared drive with superheated steam, 15 percent. 4 plates. 6,500 words.—*Transactions of the Institution of Engineers and Shipbuilders in Scotland,* November.

Canadian Railway Ferry Steamer Scotia II.—The *Scotia II* is a railway ferry steamer built recently by the Walker Shipyard, of Sir W. G. Armstrong, Whitworth & Company, Ltd., Newcastle-on-Tyne, to the order of the Minister of Railways and Canals of the Dominion of Canada in connection with the Intercolonial Railway System. The vessel is intended for service across the Strait of Canso, between the mainland in Nova Scotia and Cape Breton. The hull is 300 feet long overall, 50 feet beam extreme, 20-feet depth molded, and at a draft of 14 feet 2 inches displaces 3,665 tons. The vessel is of the single-deck type, with three railway tracks on the main deck. The hull is strengthened for ice-breaking purposes, and also for this purpose the propelling machinery was designed in two separate units on the center fore-and-aft line, the forward engines working the bow propeller and the after engines the stern propeller. A suitable coupling is fitted so that the two engines may work together or independently. Each set of engines is of the triple-expansion type, with cylinders 21, 34 and 54 inches diameter, with a stroke of 30 inches. Steam is supplied at 160 pounds pressure by four single-ended Scotch boilers arranged in the wings of the ship, with uptakes leading to funnels at each side. All of the auxiliaries connected with the propelling machinery are located in the port wing, while in the starboard wing are the electric generating sets, air pumps and air receivers for ship service and for engineers' stores. The machinery is designed to indicate 3,000 horsepower. 20 illustrations. 1,500 words. —*Engineering,* October 20 and November 19.

The Western Australian Government Motor-Ship Kangaroo.—The motor-ship *Kangaroo,* acquired by the Western Australian Government to carry produce from Western Australia to England, a voyage through the Suez Canal and back around the Cape of over 20,000 miles, was built by Messrs. Harland & Wolff, Ltd., Belfast, and equipped with Diesel type engines by the Burmeister & Wain Oil Engine Company, Ltd., Glasgow. She is 365 feet long between perpendiculars, 50 feet molded beam and 29 feet molded depth to the upper deck, with a gross tonnage of 4,348, a net tonnage of 2,777, and at a load draft of 23 feet 4½ inches, has a displacement of 6,640 tons. The bunker oil tanks have a total capacity of 814 tons, and the water ballast tanks a total capacity of 872 tons. Six transverse watertight bulkheads are fitted, and the upper and main decks are plated all fore and aft except in way of the hatches. Accommodations are provided for a number of first-class passengers. Two 100-kilowatt dynamos are fitted, driven by the Diesel oil engines that also drive the compressors in connection with the main motors. All the machinery, including the auxiliaries from the motor room, is electrically driven. 5 illustrations. 1,300 words.—*Engineering,* November 5.

Survey of New Jersey Ship Canal.—The proposed New Jersey ship canal, which is to run between the Delaware River and Raritan Bay, is to be surveyed during the winter under authority from the State of New Jersey. The surveys will be in charge of W. F. K. Griffith, under the direction of B. F. Cresson, Jr., chief engineer of the Department of Commerce and Navigation of the State. The route for this canal has already been surveyed from Bordentown to Jamesburg, so that the work remaining is for the section between Jamesburg and Morgan, the latter being the terminal point in Raritan Bay.

Shipbuilding and General Marine News

Contracts for New Ships—Marine Terminal Improvements—Recent Launchings — Improved Appliances — Personal Items

Several events of importance to marine interests have occurred sinced the first of the year, apart from the placing of a large number of contracts for new vessels and other marine construction work.

The Long Beach shipyard, Long Beach, Cal., has been taken over by the California Shipbuilding Company, primarily for the construction of submarines for the United States navy, although facilities are available at this yard for the construction of merchant vessels and it is reported that the yard will soon begin work on a large freighter.

Of special interest to shipowners is the recent announcement that the New York Shipbuilding Company, Camden, N. J., and the Newport News Shipbuilding and Dry Dock Company, Newport News, Va., have signed contracts with the Werkspoor Works, Amsterdam, Holland, for the rights to construct in this country Werkspoor marine Diesel engines for merchant and naval vessels. This marks an important step in the development of marine Diesel engine practice in the United States, as this type of engine has proved eminently suitable for economical operation in large ocean-going ships.

Shipbuilders on the sea coast and Great Lakes have recently placed orders for over 50,000 tons of plates, bars, shapes and forgings for delivery during the second and third quarters of the current year to cover the construction of vessels contracted for since the first of the year. Prospective contracts for ocean-going vessels will call for as much more steel during the current month, if contracts now under negotiation are closed.

Contracts for New Ships

The Fore River Shipbuilding Corporation, Quincy, Mass., has received a contract from the Government of the Argentine Republic to build a fuel steamship, 330 feet long, to cost about $600,000 (£123,000).

The Harlan & Hollingsworth Corporation, Wilmington, Del., has received a contract from the Ocean Steamship Company of Savannah (Savannah Line), New York, to build a large freight and passenger steamer. This is to be a duplicate of the ship recently ordered, which was reported in our January issue.

The W. & A. Fletcher Company, Hoboken, N. J., has received a contract from W. D. Pollock (Produce Exchange, New York), Manager Marine Department, New York Central & Hudson River Railroad Company, to build a double deck ferry-boat, also a tug boat.

The New York Shipbuilding Company, Camden, N. J., will build six steel car floats for the New York Central & Hudson River Railroad Company.

The Bath Iron Works, Bath, Me., will build two car floats, each 205 feet long.

The Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md., will convert the British ship *Calgary* into an oil tanker at a cost price said to be $75,000 (£15,380).

Harry Cossey, Tottenville, S. I., is building fifty wooden vessels as follows: ten steam derrick lighters, ten lumber barges, fifteen hand winch lighters, ten gasoline derrick lighters and five 1,400-ton grain barges.

It is reported that Sawyer Brothers, Millbridge, Me., will build a three-masted schooner on speculation.

R. L. Bean, Camden, N. J., will build a four-masted schooner of 1,500 tons carrying capacity.

It is reported that the Standard Shipbuilding Corporation, Shooters Island, N. J., has received contracts for all the ships that can be constructed at this yard during the next two years. All these ships are stated to be exactly alike, being 6,000-ton freighters of standard shape.

It is reported that the Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md., has received contracts from Norway to build four more oil engined ships.

The American Shipbuilding Company, Cleveland, Ohio, has received a contract from the Pittsburgh Steamship Company, Cleveland, to build another 600-foot ore boat, making three of that size ordered for 1916 delivery.

It is reported that the American Shipbuilding Company has received a contract from Carl D. Bradley, president of the Limestone Transportation Company, Rogers City, for a $500,000 (£102,500) ship for 1917 delivery.

The United Engineering Works, San Francisco, Cal., has received a contract from C. Henry Smith, Inc., San Francisco, Cal., to build a 340-foot steel freight steamship.

The Moore & Scott Iron Works, Oakland, Cal., have received a contract from Hind, Rolph & Co., San Francisco, to build a freight steamship of 7,000 tons carrying capacity, to cost about $700,000 (£143,300).

The Anderson Steamboat Company, Seattle, Wash., has received a contract from A. F. Thane & Co., San Francisco, Cal., to build four steam lumber schooners. Each of these vessels will be 248 feet long, and will have a capacity of 2,500,000 feet of lumber.

Johnson Brothers & Blanchard, Seattle, Wash., have a contract from the Westwood Navigation Company, Seattle, to build a 150-foot wooden vessel to be equipped with twin screw gas engines.

It is reported that Seattle, Wash., shipping men, headed by R. M. Calkin, traffic manager of the Chicago, Milwaukee & St. Paul Railway, are organizing a company to build and operate three steamships to ply between Seattle, Honolulu, Australia and New Zealand.

Marine Terminal Construction and Improvements

The Pennsylvania Railroad Company, Broad Street Station, Philadelphia, Pa., has asked for bids for improving and enlarging Pier 46, Philadelphia.

The Donner Steel Company, recently incorporated in New York State with $5,000,000 (£1,025,000) capital, has taken over the plant of the New York State Steel Company, Buffalo, and will make extensive improvements, including building ore docks along the Buffalo River.

The Norfolk Storage Company, Inc., recently organized at Norfolk, Va., has purchased a site of 19 acres near Norfolk and will build docks and sheds.

The Freeport Sulphur Company, Freeport, Tex., is planning to construct a dock.

It is reported that Leon Fighiera, Ocean Park, Cal., is planning to build a pleasure pier, to cost about $1,000,000 (£205,000).

J. R. Jervey, engineer, Richmond, Va., has submitted to the Council Committee on Rivers and Harbors, plans

for docks and terminals at an estimated cost of about $3,000,000 (£615,000).

The City of Hampton, Va., is considering a $90,000 (£18,450) bond issue to build docks and to make other improvements.

The Board of Trustees of Manhattan, Cal., are considering the construction of a pleasure pier at a cost of about $70,000 (£14,350).

The Santa Monica Land Company, Santa Monica, Cal., is considering the construction of a 560-foot wharf.

The Board of Estimate of the City of New York has appropriated $55,000 (£11,280) for building a pier at Coney Island. R. A. C. Smith, Pier A, North River, New York, is Dock Commissioner.

New Steamship Lines

W. A. Rousch, G. W. Hubbell and others of Macon, Ga., have incorporated the Gray Boat Line.

William Wallis and Hollis Fort, of Americus, Ga., and J. M. Sumner and E. E. Cooke, of Akron, Ohio, have organized the Flint River Navigation Company, capital $25,000 (£5,130) and plan to operate boats on the Flint and Appalachicola rivers.

Frank E. Mathews is president and general manager, W. S. Bullock is treasurer and B. J. Hunter is secretary (all of Ocala, Fla.) of the recently organized Oklawaha-Silver Springs Steamboat Line.

Shipyard Extensions and Improvements

Harold M. Sewall and others of Bath, Me., have purchased the shipbuilding plant of the New England Company, of Bath, which has been idle for more than ten years. It is reported that the yard will shortly be operated for building wooden ships.

It is reported that W. A. Boole, Jr., Oakland, Cal., is at the head of a new company which will build a large shipyard at Oakland.

Isherwood System of Ship Construction

Although the year 1915, so far as Great Britain is concerned, has not offered many facilities for the building of mercantile vessels, owing to the demands made upon shipbuilders by the Government, it is very interesting to note that this has been a record period for the "Isherwood" system, orders for more Isherwood vessels having been placed this year than in any preceding year. The total number of Isherwood vessels contracted for to date in the current year is no fewer than 135, approximating to 615,315 gross tons, which is almost equal to 1,000,000 tons in deadweight carrying capacity.

The following analysis of vessels built or being built clearly demonstrates the suitability of the Isherwood system for all types of craft, and at the same time emphasizes the predominance it has gained in the construction of certain classes of vessels:

			Gross Tons
General cargo vessels.	167	Representing about	745,763
Tankers	187	" "	1,054,783
Colliers	21	" "	130,760
Great Lake freighters.	16	" "	111,745
Passenger vessels	9	" "	27,769
Barges	43	" "	12,742
Dredgers	2	" "	760
Trawler	1	" "	570
	446	" "	2,084,892

As may be readily imagined, the advantages of the Isherwood system have not been overlooked by the Government, and orders for several tank steamers have been placed by the Admiralty, and other types of boats have been contracted for by the Indian Government. In the United States, three more large freighters for the American Lake trade have been placed on order, and to evidence the firm footing the system has gained in Japan, it might be stated that 22 vessels have recently been contracted for.

Among the most interesting vessels delivered during the period under review, mention should be made of the ore carriers *Rose Castle* and *Lord Strathcona*. These vessels, which have been specially designed for the carriage of coal and ore, are the largest single-deck vessels ever built in the United Kingdom. In the United States, the *Achilles* and *Ulysses* have been placed in commission by the Panama Canal Commissioners, for whom they were specially built. Those two vessels are also high-class colliers, and are very similar to the colliers *Orion* and *Jason*, which were designed and are operated by the United States navy department. That the Isherwood system should be selected for the construction of what are undoubtedly the six finest colliers in the world would seem to indicate that the claims which have been made for it in connection with this class of steamer are based on quite a substantial foundation.

New York and Newport News Shipbuilding Companies to Build Big Motor Ships

T. Orchard Lisle, United States representative of the Netherlands Engineering Company, of Werkspoor Works, Amsterdam, Holland, announces that the Newport News Shipbuilding Company, of Newport News, Va., and the New York Shipbuilding Company, of Camdem, N. J., have signed contracts with the above well-known Dutch firm whereby they will construct under license in the United States, Werkspoor mercantile-marine and naval, four-cycle, Diesel-type motors.

For several years both the Newport News Shipbuilding Company and the New York Shipbuilding Company have been closely watching the development and progress of the Diesel-driven motor ship, and they are to be congratulated on being the first American concerns to adopt Diesel engines of a slow-speed type suitable for large ocean-going ships. Their choice of design was influenced, of course, by the splendid results accomplished by the twenty-two Werkspoor Diesel-engined ships now in service and also by the remarkable possibilities of the Werkspoor submarine Diesel engine.

In many ways this step is important, especially when it is considered that the famous East Asiatic Company, of Copenhagen, has sold all its steamers and is rapidly replacing them with Diesel-type motor-driven liners. In fact, one well-known Danish firm of shipbuilders actually has on order more mercantile motor-driven ships than any shipbuilding firm in the world has steamships building.

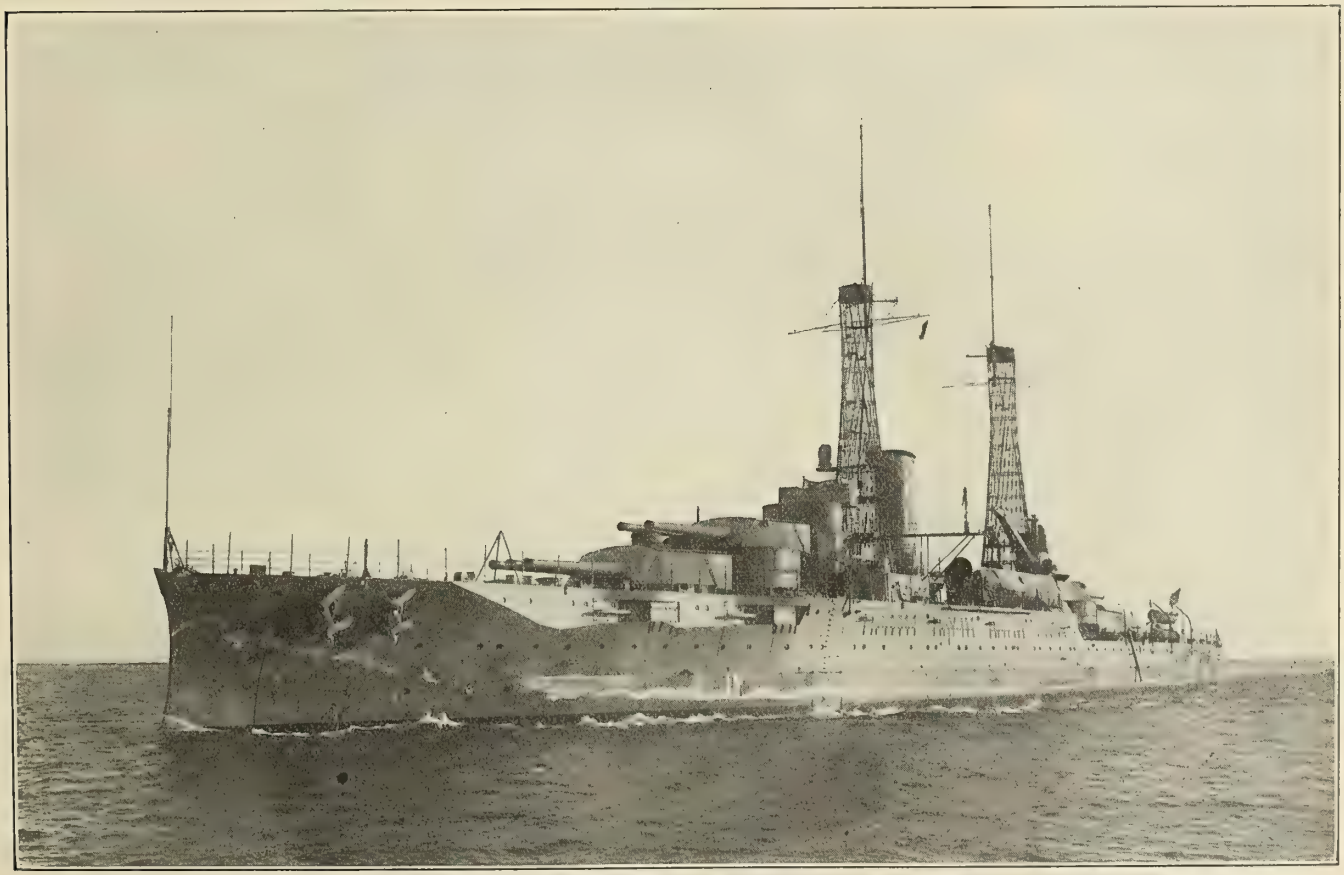
The economies obtained, due to the fact that there are no large boilers or stokeholds in a motor ship, and because the consumption of oil fuel is only one-fifth that of a similar coal or oil-fired steamer, so that the bunker and boiler spaces thus saved can be given over to extra cargo, mean that with a tramp of 10,000 tons, about 600 tons of extra cargo can be carried, and at the present high rate of freights the economical advantage in a year is enormous, apart from the large saving on the fuel bill.



United States Destroyer *Jacob Jones*, Built by the New York Shipbuilding Company, Camden, N. J., on her Official Trial Trip

Oklahoma Exceeds Her Contract Speed

The new United States superdreadnought *Oklahoma,* which went through the first of her official trials over the Rockland course off the coast of Maine on January 15, attained a speed of 21.47 knots, or nearly a knot above her contract speed. The *Oklahoma,* which is driven by reciprocating engines, was built by the New York Shipbuilding Company, Camden, N. J., and is a sister ship to the *Nevada,* built by the Fore River Shipbuilding Corporation.



United States Superdreadnought *Oklahoma*, Built by the New York Shipbuilding Company. Trial Speed, 21.47 Knots

Launching of S. S. Texas

The launching of the new steamship *Texas*, the latest and finest of the Texas Company's fleet of tank steamers, took place on December 21, 1915, at the yard of the Fore River Shipbuilding Corporation, Quincy, Mass., attended by ceremonies befitting the occasion. The vessel was christened by Miss Frances Edwina Brooks.

The *Texas* went overboard in remarkably quick time, only twenty-seven seconds elapsing from the releasing of

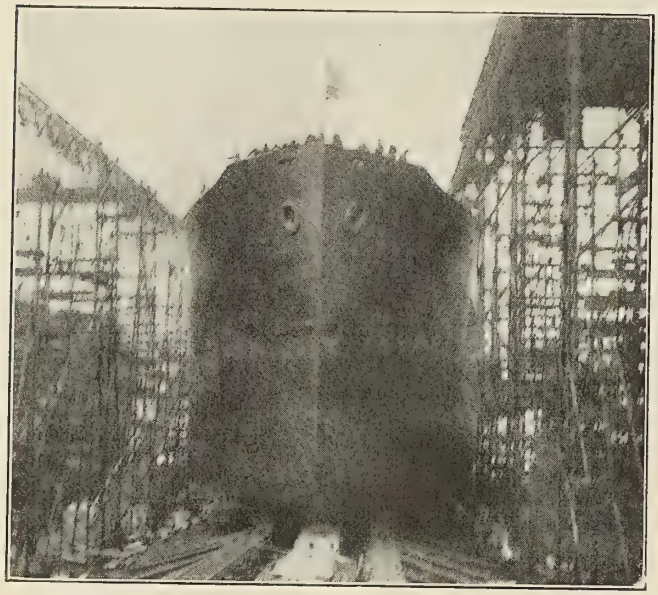


Fig. 1.—The *Texas* Going Down the Ways

the trigger until the ship was afloat. The vessel, which was designed by Mr. George B. Drake, assistant manager of the Marine Department of the Texas Company, is constructed to Lloyd's highest class, and is built on the Isherwood system of longitudinal framing. Throughout her design and construction the latest and best methods of tank-vessel construction have been followed.

The ship is 430 feet long overall, 56 feet beam, 32 feet 9 inches deep, and has two continuous steel decks, raised forecastle, bridge and poop decks, and a lower deck in the package freight hold. The hold is divided by oiltight bulkheads into compartments for sixteen main oil cargo tanks, sixteen summer tanks, fuel oil tanks, two pump rooms, cargo hold forward, machinery space aft, peak trimming tanks at ends and double bottom under engine and boiler space. The ship is schooner rigged, with two steel masts.

The *Texas* will have a total deadweight carrying capacity of 9,100 gross tons on 25-foot 6-inch draft. The cargo tanks have a total capacity of 73,000 barrels, or 3,066,000 gallons. Her contract speed is 11 knots, loaded.

Particular attention has been paid to the arrangement of quarters and everything provided for the comfort and safety of the crew, including a hospital. Marconi wireless will be used, as on other ships of the line. The *Texas* will carry various grades of refined oils without danger of mixture, and the cargo pumping system has been carefully worked out to the best point of efficiency, under the personal direction of Mr. Thompson. A refrigerating plant will be installed, complete electric lighting outfit, including searchlight, steam capstan, windlass, cargo winches, mooring machines, steering gear, etc.

The propelling machinery consists of one three-cylinder, triple-expansion engine, with cylinders 26½ inches, 44 inches and 74 inches diameter by 51 inches stroke, designed for a maximum speed of 75 revolutions per minute. Steam is supplied by three single-ended Scotch boilers, 15 feet 3 inches diameter by 11 feet long, working at 190 pounds pressure. Oil fuel will be used, with a mechanical atomizing system. A donkey boiler is also provided for use when in port and when desired to assist in getting up steam on the main boilers.

A steam heating system is provided for all living quarters, and steam heating coils for fuel tanks and such other tanks as may be used for heavy oils. Steam fire-extinguishing pipes are run to all tanks.

The *Texas* is the first of four sister ships which the Fore River Shipbuilding Corporation is building, two for the Texas Company and two for the Texas Steamship Company. The second ship, which will be named the *New York*, will be launched in about two months, and delivery of the last two vessels is called for about January and March, 1917.

The original steamship *Texas*, which has faithfully served as flagship from 1907 until the *Illinois* came out, in 1913, has now ceded both her name and former title to the new *Texas*, and will be renamed the *Georgia*.

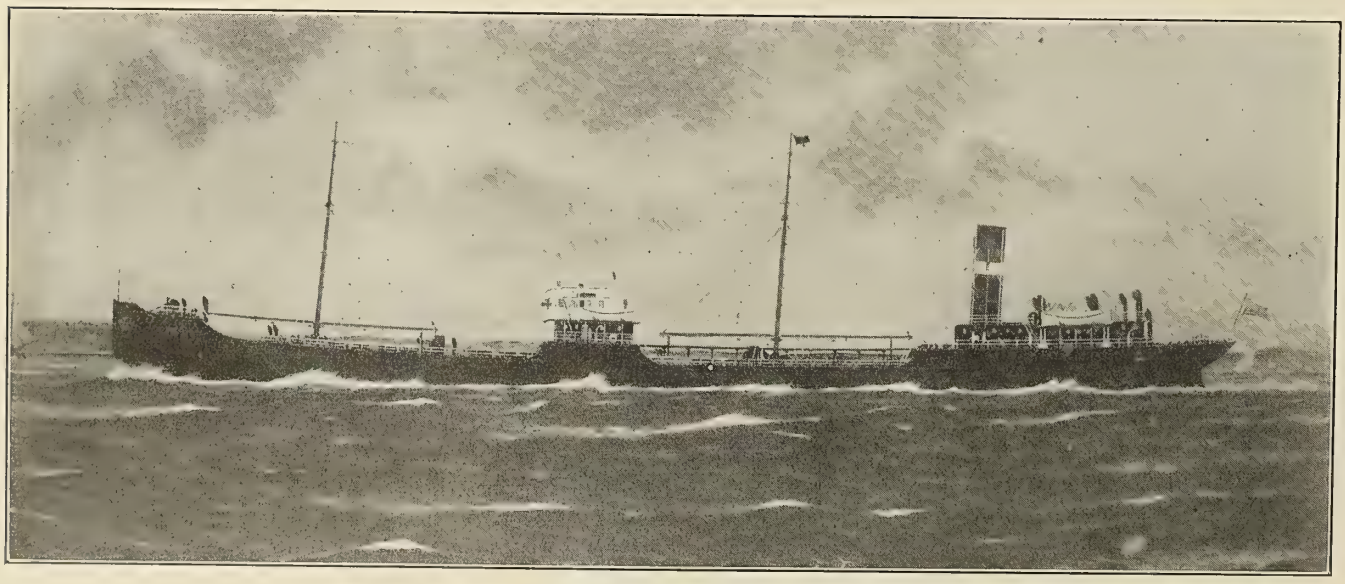


Fig. 2.—The Oil Tanker *Texas*, as she will Appear when Completed



(Photograph by Edwin Levick, New York)

A Sturdy Competitor of the Modern Steamship

ENGINEERING SPECIALTIES

Boilers of New Coastwise Colliers Equipped with Eckliff Automatic Boiler Circulators

The boilers of all of the large new colliers recently built or now under construction by the New York Shipbuilding Company, Camden, N. J., for the Coastwise Steamship Company and the Pocahontas Navigation Company have been equipped with Eckliff automatic boiler circulators, manufactured by the Eckliff Automatic Boiler Circulator Company, Detroit, Mich. In all, twenty-four Eckliff circulators have been installed in ships building for the Coastwise Transportation Company, and eight in ships for the Pocahontas Navigation Company. These vessels, which are over 300 feet long and of about 5,000 tons deadweight, capable of about 10½ knots speed at sea, form the largest fleet of colliers under American registry, and every device conducive to reliability and economy of operation has been embodied in their design. It is not surprising, therefore, that in order to improve the economy of fuel consuption and to eliminate boiler troubles due to poor circulation, Eckliff automatic boiler circulators should be installed in the boilers of all of the vessels of this fleet.

DeLaval Turbine-Driven Compressor

The construction of the DeLaval multi-stage compressor, manufactured by the DeLaval Steam Turbine Company, Trenton, N. J., is such that the casing is split horizontally, permitting of the top half or cover being lifted off, so that internal parts may be inspected and lifted out after removal of the bearing caps. The impellers are mounted upon a large-diameter and stiff shaft, the critical speed of which is far above the running speed, and which is made from hammer-forged, open-hearth steel, suitably heat treated and ground and polished over the entire surface on dead-center grinders. The hubs of the wheels and impellers are attached to the shaft by keys and separated from one another by shaft-tightening rings, which run inside the split packing rings attached to the diaphragms separating the stages. The diaphragms between stages are separate from the casing and are divided on a horizontal plane so that they may be removed without removing the shaft and impellers. When cooling is employed, the diaphragms are hollow, the water entering through the bottom of the casing and escaping at the top.

The impellers are of the single-suction, shrouded type, and are built up on heat-treated, forged, chrome-nickel steel disks, the blades or vanes being riveted to the disks and to side plates, turned tapering to give strength and lightness. That part of the disk which is within the circle of the suction opening is subjected on the inlet side to the suction pressure and on the back to the discharge pressure of the individual stage, which gives a resultant thrust equal to the area of the suction opening multiplied by the pressure generated. The accumulated thrust of all the stages is overcome by a balancing disk at the discharge end, so arranged that one side receives the total discharge pressure in a direction opposite to that acting upon the impeller disk, while the chamber upon the opposite side of the balancing disk is connected to the suction inlet, thus completely neutralizing the unbalanced pressure on all of the wheels. The head delivery characteristic can be varied considerably to meet different requirements.

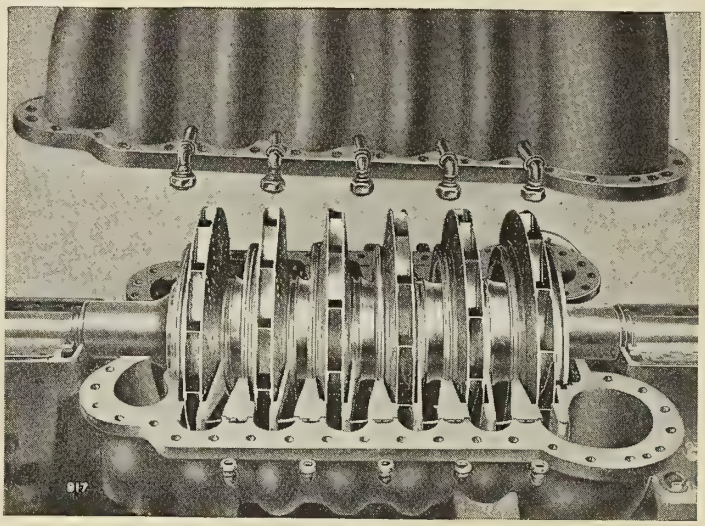


Fig. 2.—Multi-Stage Compressor with Cover Lifted

Generally where compressed air is used in tools, as around machine shops, shipyards, etc., a fairly constant pressure over a wide range of delivery is desired. The capacities in such cases range between 2,000 and 10,000 cubic feet per minute and the pressures from 75 to 120 pounds per square inch. Less than 2,000 cubic feet per minute is usually not practicable. The larger machines, or machines which must run at motor speeds, are usually built in two sections; that is, with two shafts and two housings, the speeds available with electric motors of

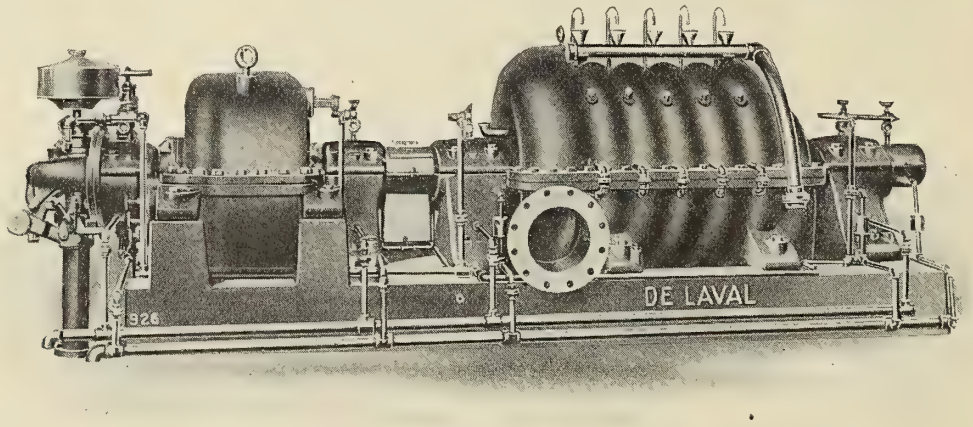


Fig. 1.—DeLaval Turbine-Driven Multi-Stage Air Compressor

these sizes requiring either a compressor with a large number of stages and several housings, or the use of a step-up gear, by means of which the compressor can be operated at 4,000 to 5,000 revolutions per minute. It may be noted that in shipyards it is frequently desirable to centralize the power generated in large turbo electric units and to operate compressors and blowers, pumps, hoists, etc., by motor, the 10 percent or so loss in electrical transmission not being so great as the loss from widely separated steam using units, and the compressor load of 1,000 or 2,000 horsepower forming a good foundation for the turbo-generator load.

The Viking Rotary Pump

A durable pump of simple construction, for which high efficiency in a large range of heads and speeds with a minimum of wear is claimed, has been placed on the market by the Schirmer-Frensdorf Company, Cleveland, Ohio, and is known as the "Viking" rotary pump. The only moving parts of the pump are a small spur gear and a large annular gear arranged as shown in Fig. 5. The small spur gear driven by the large annular gear is set off center and meshed so that its outer circle is tangent to the outer circle of the large gear at the center of the abutment between the inlet and outlet. The large gear wheel has a shaft at the back which extends through the pump casing and carries a pulley used for driving. The crescent-shaped projection of the head fills the space between the outer circle of the small gear and the inside circle of the large gear on the opposite side of the shafts.

After the water enters the pump it is carried around in the pockets formed by the spurs of both gears and the crescent-shaped abutment. When the gears begin to mesh, the water is forced into the outlet port. The abutment between the ports then prevents its passage back into the entrance port, so that it must go on into the outlet pipe.

Test runs have been made with heads varying from approximately 30 to 150 feet of water, and with speeds from 300 to 450 revolutions per minute, referring to the shaft of the large gear on which the pulley is mounted. The efficiencies were taken as the ratio of the horsepower delivered to the water pumped to the horsepower supplied to the driving pulley. The average of runs taken with a 2-inch pump showed a minimum efficiency of 48.6 percent and a maximum efficiency of 76.3 percent.

No foot valve is required for starting the water for any reasonable lift. Only one moving part requires packing, the main shaft where it enters through the back casing.

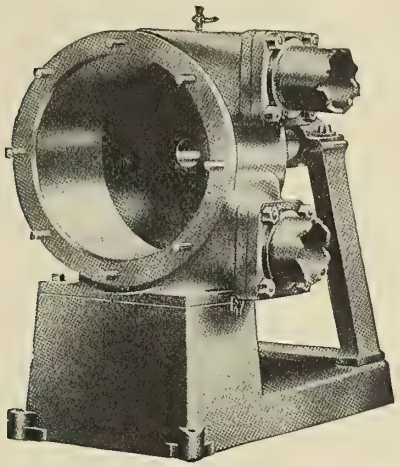


Fig. 1.—Casing of Pump

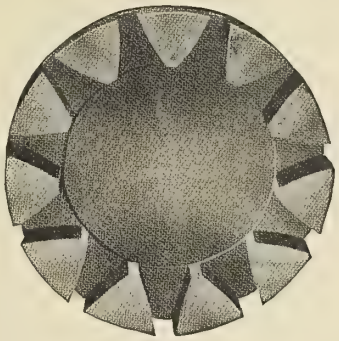


Fig. 2.—Annular Gear

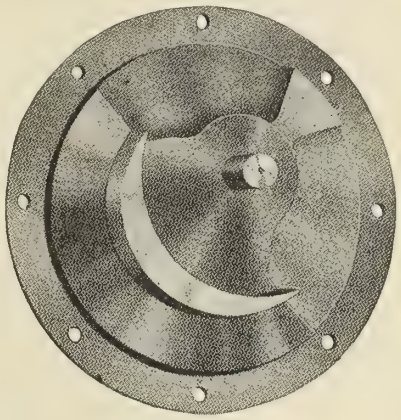


Fig. 3.—Cover

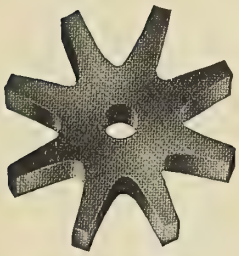


Fig. 4.—Spur Gear

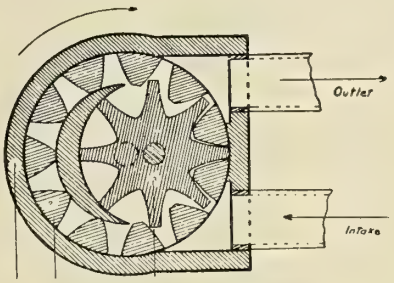
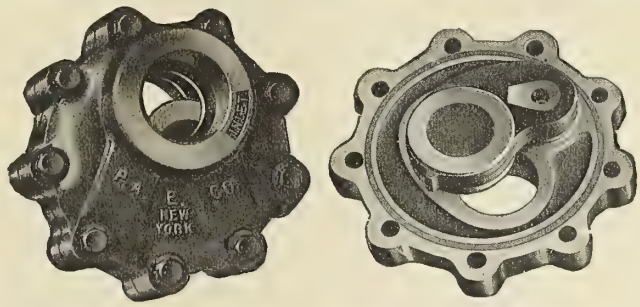


Fig. 5.—Section Through Pump

Everlasting Blow-off Valve

The Scully Steel & Iron Company, Chicago, Ill., has placed on the market a marine type of the "Everlasting" blow-off valve, which has an extra heavy body and is guaranteed to pass government inspection. The valve is especially designed to meet marine requirements and is composed of a top and bottom bonnet bolted together with an approved high-pressure gasket between them. The valve has no stuffing box, and, for this reason, requires no packing or repairing. After it is once installed it requires no attention from the engineer outside of operating it. The valve has a straight-through blow, thus eliminating the deposit of sediment in any part of the valve. The disk has a rotating movement over the valve seat, which makes it self-grinding and keeps the surface true. The inlet orifice is slightly choked, which increases the velocity of the blast at that point and insures its delivery into the discharge pipe without impairing the seat. This also has the effect of syphoning the valve clean at each operation.

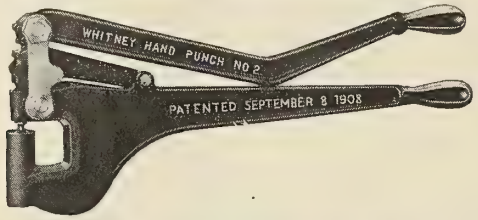


Exterior and Interior Views of Everlasting Blow-off Valve

The valve can be used anywhere where a quick opening or closing valve is required, and many large steamship companies on the Atlantic and Pacific coasts, as well as on the Great Lakes, are using the valve, not only in blow-off service, but also on purifiers. It is made with screwed or flanged ends, or with one end screwed and the other flanged, and also with angled ends. If a slow-opening valve is required it can be furnished with a rack and pinion device.

Portable Channel Iron Punch

The W. A. Whitney Manufacturing Company, of Rockford, Ill., has just added a portable channel iron punch to their line of portable hand metal punches. All parts of their No. 2 punch are interchangeable with this new channel iron punch, including punches and dies. The only



Whitney Portable Channel Iron Punch

part that is different from the No. 2 punch is the drop forged lower jaw, which has an opening back of the die socket that allows channel and angle iron to be pushed through and punched in the web between the flanges. The capacity of this channel iron punch is a ¼-inch hole through ¼-inch iron. It punches to the center of 4-inch channel iron, with 1½-inch flanges.

Cedervall Patent Protective and Lubricating Box for Propeller Shafts

To prevent the access of water to the stern tube of a vessel and to provide a reservoir of oil for lubricating the whole bearing surface of the tail shaft so that it runs virtually in an oil bath with a minimum amount of friction, F. R. Cedervall & Söner, Gothenburg, Sweden, have patented and are manufacturing a protective and adjustable lubricating box. The device, which is made of brass throughout, consists essentially of two concentrical rings fitted around the propeller shaft. The outer ring is fixed to the forward end of the propeller boss by means of screws and serves as a packing box. The inner ring, the working surface of which is faced with anti-friction metal, is pressed to the after end of the propeller tube by means of a series of spiral springs fitted between the two rings. By this arrangement it is possible to obtain a watertight joint at the stern tube. An important arrangement has also been incorporated in the lubricating box so that it is adjustable and can be lengthened or shortened as required, within practical limits and yet retain the proper compression on the spiral springs.

The protective box, together with the shaft and the end tube, forms an oil reservoir in the shape of a ring, from which the oil cannot escape, and into which the water cannot gain access. Oil is brought to the reservoir by means of grooves cut in the stern tube bush and connected with a pipe system for filling and draining the tube.

The complete arrangement of a stern tube fitted with the adjustable lubricating box and oil connections is shown in Fig 2. Three or more grooves are cut in the stern bush in the position shown in the illustration. The top one is for the escape of oil, and the others are for leading the oil to the reservoir. From the stern tube three pipes are carried through the aft bulkhead to any convenient place for connection to the supply of oil. The length of the after bush should be from four to four and one-half times the diameter of the shaft and of the forward bush from one to one and one-half times the diameter of the shaft.

The advantages claimed for this device are an increase in the number of revolutions of the engines, efficient lubrication of the tail shaft, elimination of costly brass liners and lignum vitæ bearings; elimination of galvanic action and protection of the propeller shafts from breakdowns.

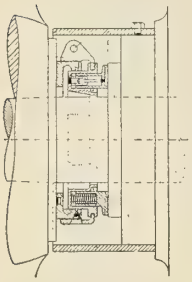


Fig. 1.—Adjustable Lubricating Box

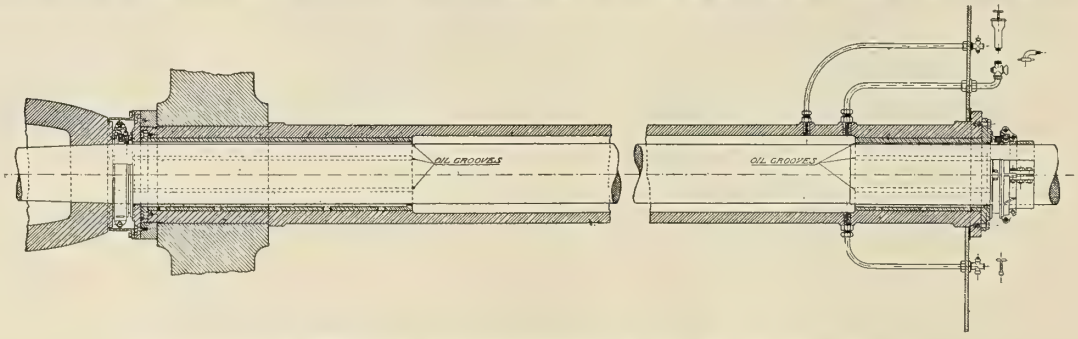
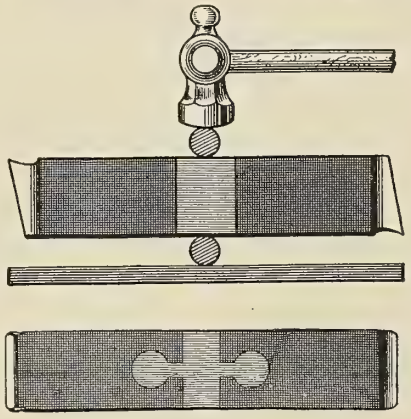


Fig. 2.—Stern Tube Fitted with Adjustable Lubricating Box and Oil Connections

"Gauge=All" Expansible Double Boring Bar

Owing to the comparatively limited quantity of high-speed tool steel which is available in the countries which are at war, and its high price and indispensability, Messrs. Vislok, Limited, 3 St. Bride's House, Salisbury Square, London, E. C., have placed on the market an expansible



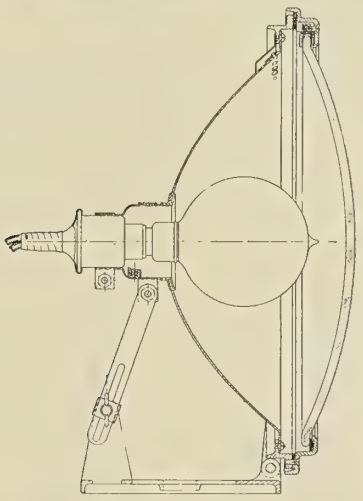
"Gauge-All" Boring Bar

double-boring cutter in which two pieces of high-speed tool steel, forming the cutters, are joined together at the center by a section of special soft metal alloy. When, after the usual wear, it is necessary to expand the tool to

its original diameter, it is only necessary to place an iron or brass clip around the center and strike it lightly with a hammer, as shown in the illustration. This compresses the metal alloy and expands the cutter. By regulating the hammer blows minutely, accurate expansion is obtained and the expansion is carried out with the cutter in use, thus eliminating frequent visits to the tool room and other delays. It is claimed that the "Gauge-All" tool enables the maximum value to be realized from the extremely expensive and increasingly rare high-speed tool steel.

Flood-Lighting Projector

A device for projecting a beam of light from a distance on to a place where work is being carried on at night, as, for instance, around docks when coaling or loading ship or on shipboard when coaling ship, has been developed by the Edison Lamp Works, General Electric Company, Harrison, N. J. The projector consists of a highly polished aluminum parabolic reflector 1/16 inch thick and 16



Sectional Drawing of Complete Flood Light Projector

inches in diameter, mounted on an iron frame. The front of the reflector is covered with a piece of round heat-resisting glass which is clamped to the reflector frame in such a manner that the whole is waterproof. A 500-watt, focus-type, nitrogen-filled lamp is employed with the projector. The spread of the beam can be controlled by moving the lamp in and out of focus and the beam may be concentrated to about 6 degrees divergence with an apparent candle power in the center of slightly over 400,000 by placing the filament exactly at the focus, or by drawing the filament behind the focus, the beam may be spread to 18 degrees with an apparent candle power of approximately 150,000 in the center of the beam. The entire outfit weighs about 30 pounds.

PERSONAL MENTION

Operating Engineers

Melvin Leap, of Cincinnati, Ohio, has been assigned to the river stamer *J. M. Ware* as chief engineer, vice Nora Ellis, retired.

Samuel Ellis, of Cincinnati, Ohio, has been appointed first assistant engineer on the river steamer *Mayme Barrett,* at Cairo, Ill.

C. S. Follett has been elected president of the Marine Engineers' Beneficial Association No. 38, Seattle, Wash., succeeding J. S. Wright. The other officers of this branch of the association for the coming year are F. A. Farr, first vice-president; George W. Hill, second vice- president; W. B. Jackling, corresponding secretary; W. M. Coombs, financial secretary and treasurer.

Changes in United States Steamboat Inspection Service

Chester W. Willett has been appointed assistant inspector of hulls at Milwaukee, Wis., and has been assigned to Chicago for duty.

Thomas E. Kell, local inspector of boilers at St. Michael, Alaska, was killed recently in an automobile accident.

John W. Fleming, assistant inspector of boilers of New York, died recently.

Naval Architects, Consulting Engineers, Draftsmen, and Shipyard and Steamship Officials

Maynard D. Church has been appointed chief engineer of the Terry Steam Turbine Company, Hartford, Conn.

Henderson Weir, secretary of the Harlan & Hollingsworth Corporation, Wilmington, Del., has been elected a director of the corporation.

S. K. Smith has been elected vice-president of the Harlan & Hollingsworth Corporation, Wilmington, Del., succeeding Persifor Frazer. Mr. Smith is also treasurer of this corporation.

George A. Swain, who has been connected with the Southern Pacific Company in New York for nearly thirty years, has been appointed terminal superintendent of the Southern Pacific piers at New York. John Mackin has been appointed assistant to Mr. Swain.

W. J. A. London, for many years connected with the steam turbine business, has become works manager for the Sterling Blower Company, mechanical experts in the manufacture and installation of blowers and blower systems of all kinds, at Hartford, Conn.

E. C. Waldvogel, who has been connected with the Yale & Towne Manufacturing Company, New York, for the past eleven years as traveling salesman, sales manager and assistant general manager, has been appointed general manager of the company, with general supervision of all sales, domestic, Canadian and export.

OBITUARY

Wilfred R. Dean, vice-president of the Dean Bros.' Pump Works, Indianapolis, Ind., died recently, after a protracted illness, aged sixty-eight years.

George D. Rollins, for several years general manager of the Holmes Metallic Packing Company, Wilkesbarre, Pa., died in Philadelphia on December 16, aged eighty. Mr. Rollins became associated with the Holmes Metallic Packing Company in 1901, and served as general manager until the time of his death.

Colonel Edwin D. Metcalf, president and founder of the Columbian Rope Company, Auburn, N. Y., died at his home in that city on December 31, aged sixty-seven. Colonel Metcalf came to Auburn from New England in 1890 to become treasurer and general manager of the D. M. Osborne Company, manufacturers of farm machinery. In 1903 the International Harvester Company bought the plant of the Osborne Company, and Mr. Metcalf established the Columbian Rope Company, which he developed until to-day it ranks among the largest and best-known cordage factories in the world.

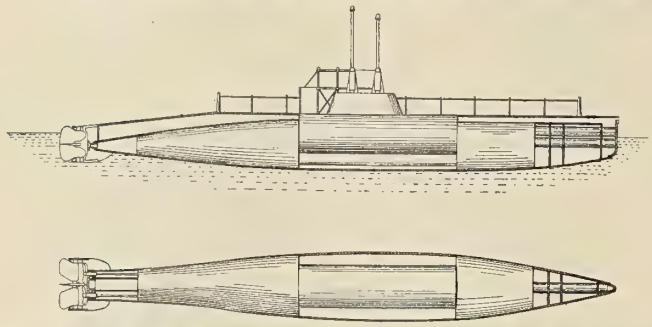
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,154,215. HULL CONSTRUCTION OF SUBMARINE BOATS. LAWRENCE Y. SPEAR, OF QUINCY, MASS., ASSIGNOR TO ELECTRIC BOAT COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

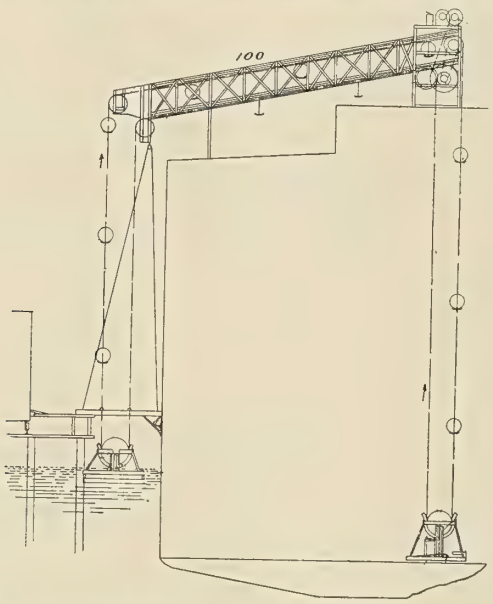
Claim 1.—A hull construction for submarine boats, comprising a double hulled midship section consisting of an inner strong hull and an outer weak hull, and a single strong hull section forward and one aft of said midship section, the center line of the volume of the inner



strong hull of the midship section lying above the center line of the volume of the forward and aft strong hull sections, said single strong hull sections forming continuations of the weak hull of said midship section. 18 claims.

1,156,653. SHIP LOADER OR UNLOADER. BENJAMIN H. ALVEY, OF ELIZABETHTOWN, KY.

Claim 3.—A ship loader or unloader comprising an endless traveling conveyor guided to provide an intermediate section and sections depending from the ends thereof, said conveyor having pivotally suspended package carriers, a loading device supported in operative relation with one of said end sections, said loading device being provided with means



for supporting packages in the path of the package carriers and arranged to be moved on its support with swinging movement of said section, the latter having traveling movement relatively to said device and extending below said device and being freely suspended. Thirty-one claims.

1,165,183. DAVIT-FALL ATTACHMENT. FERDINAND W. KROGH, OF SAN FRANCISCO, CAL.

Claim 1.—A davit-fall attachment comprising companion hooks engaged together and means between said hooks to release said engagement, one of said hooks being secured to the fall and the other to the boat. Eight claims.

1,153,475. MARINE TURBINE. KARL ALQUIST, OF SCHENECTADY, N. Y., ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

Claim 1.—In a sytem of ship propulsion, the combination of main turbines arranged to propel the ship at maximum speed, cruising turbines arranged to co-operate with the main turbines to propel the ship at speeds below the maximum, and means arranged to connect the cruising turbines in series with the main turbines as regards the flow of steam for intermediate speed conditions and to connect the cruising turbines serially as regards the flow of steam and to supply the exhaust therefrom to the main turbines in parallel for lower speeds of the ship. 7 claims.

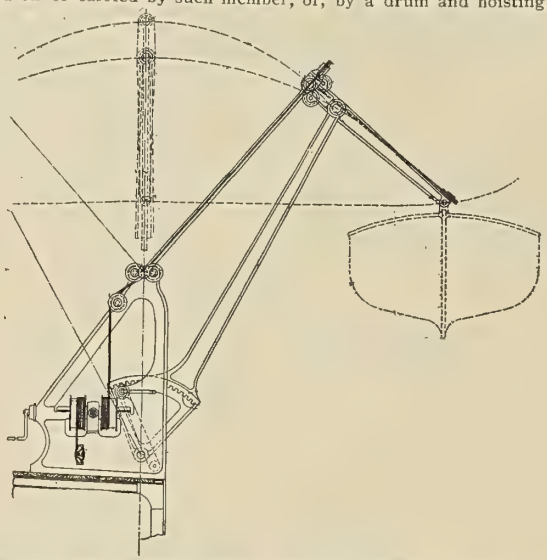
British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn place, W. C., London.

5674/14. APPLIANCE FOR RENDERING SHIPS UNSINKABLE. A. PIERROTTET, 31 VIA XX SETTEMBRE, GENOA, ITALY, ENGINEER.

According to the invention the unserviceable spaces such as the spaces between the framings, the cargo battens, the bulkhead stiffeners, the deck beams, and so on, are lined, or if desired are wholly or partly filled with a compound of small specific weight, such as cork chips, sawdust and the like, kneaded up with tar, cement, or any like substance, the compound when desired being made lighter by hollow spaces inside the mass, which is applied either in the form of a paste or as a concrete. The volume, weight and arrangement of the whole is such that on one or several compartments being flooded, the material will suffice to insure the buoyancy and the stability of the ship, either until those on board have been rescued or under certain circumstances until the ship itself has reached port.

20,813/14. SHIPS' DAVITS. J. M. DESCHAMPS, OF 63, CHANCERY LANE, LONDON, MIDDLESEX.

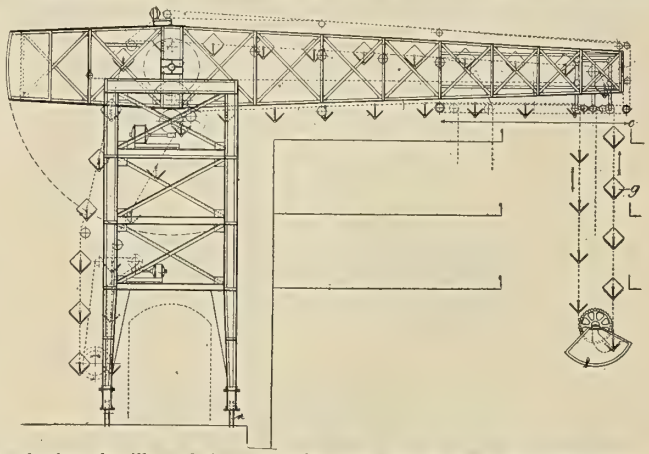
This invention relates to davits for ships' boats of the type in which the main supporting member is actuated; that is, thrown inboard or outboard past the fixed frame or support, by means of a toothed rack formed on or carried by such member, or, by a drum and hoisting chain



or rope, the load carrying member being controlled by the movement of said main supporting member and so mounted thereon that the free end of the load carrying member travels in an approximately straight line. The objects are to enable an enlarged throw inboard and outboard to be obtained without excessive height, to maintain a straight path of travel for the boat to enable several tiers of boats to be handled and to combine, if desired, with the davits a lowering device for operating the falls and the load, preferably with single wire or other ropes.

1,145/15. LOADING AND DISCHARGING THE SHIPS' CARGOES. A. FRANKLIN, OF 70, WILMINGTON GARDENS, NEW BARKING, ESSEX.

A crane jib or a balanced girder is mounted upon a traveling base in combination with a conveyor or elevator running along the jib or girder and depending from each end thereof, the arrangement being preferably



such that the jib or balanced girder with the elevator depending therefrom may be moved from a more or less vertical position to an inclined or horizontal position in which the outer end of the jib or balanced girder may be adjusted as to height and thereby adjust the pending end of the elevator to the required height in the ship's hold to receive or deliver goods to be handled. The said combined jib or girder and conveyor is preferably arranged in relation to another conveyor delivering or receiving goods from the adjacent sheds or warehouses. If required, the elevator itself may be arranged to be adjustable as to length independently of the position of the crane jib or balanced girder.

INTERNATIONAL

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The Shipbuilding Situation

OWING to the destruction of nearly 2,000,000 tons of shipping since the outbreak of war in Europe, and the withdrawal of a considerable portion of European shipping from commercial service, urgent demands for new tonnage have rapidly spread throughout the world, bringing to the shipbuilders of all neutral countries a period of unprecedented prosperity. This impetus to shipbuilding has been strengthened by the virtual cessation of merchant shipbuilding in the warring countries, which heretofore were the largest producers of merchant tonnage in the world, and by the extraordinary opportunities offered for realizing handsome profits either by the sale of vessels built on speculation or by the operation of vessels at very remunerative rates in the general cargo trade.

Nowhere have the results been more pronounced than in the shipyards of the United States. After many years of comparative inactivity, American shipbuilders were suddenly confronted with a volume of business calling for an immediate increase of working forces and a general speeding up of the output of the yards to make way for the taking of new contracts at abnormal prices. To take advantage of the business offered many of the yards found it necessary to add materially to their equipment and provide additional building facilities, as is described elsewhere in this issue. With the continued increase of orders, however, difficulty was experienced in securing early deliveries of steel, with the result that contracts for new vessels recently placed in most of the yards have been contingent not only upon the availability of building berths, but also upon the delivery of steel for the construction of the vessels, a factor which has undoubtedly restricted to a certain degree the legitimate expansion of some of the shipbuilding facilities. Difficulties in securing skilled shipyard labor have also placed the shipbuilders in a position where it has become necessary to resort to the training of inexperienced employees in the yards for the special class of work required for shipbuilding.

Aside from the fact that the present favorable conditions will undoubtedly continue as long as the war lasts, and probably for a limited period after hostilities are ended, the future expansion of the American shipbuilding industry depends upon the establishment of a definite policy for upbuilding the American merchant marine for foreign trade. With few exceptions the merchant tonnage now under construction is for domestic use. Not until shipowners can be assured of some definite national policy by which the American merchant marine can attain a permanent growth in overseas trade will the shipbuilding industry in the United States be placed on a sound basis for its future expansion.

While the present situation may tend to more nearly equalize the costs of construction of American and foreign-built ships, owing to the higher costs abroad and the opportunity which American shipbuilders now have, on account of a large and constant volume of production, to standardize the building of special classes of ships, this factor alone will not restore the American flag to the high seas. It is only by means of a definite policy of positive government protection for American shipping that our former commercial supremacy at sea can be regained.

How such protection shall be furnished and applied—if it is forthcoming—rests entirely with Congress. Many excellent suggestions from men who have spent years in the shipping or shipbuilding business are given in the following pages. In most of the legislation that has so far been proposed, however, one feature at least which has met with general approval predominates. This is the establishment of a Federal shipping board invested with sweeping powers for the direction of American marine affairs. One of the first duties of such a board would be to investigate the relative costs of building and operating ships in this country and abroad and to prescribe remedial measures by which this obstacle could be overcome. Following this it should recommend revisions of the United States navigation laws and the removal of restrictive legislation affecting the American merchant marine. With some of the obstacles to economical operation of ships removed and an authoritative body of men to recommend to the administration the kind of legislation that will provide the necessary protection to American shipping, it is believed that an American fleet for foreign trade will be developed.

National Protection Necessary

Without the development of an American merchant marine for foreign trade, the future of the American shipbuilding and shipping industries will be but a repetition of the inactivity of the past twenty-five years.

As the present revival of American shipbuilding is a direct result of abnormal conditions caused by the European war, to rely solely upon these conditions for the restoration of the American flag upon the high seas is to leave the matter to fate.

To develop an adequate merchant marine for overseas commerce the United States must give positive national protection to American shipping.

The Shipbuilding and Shipping Situation

Views of Leaders in the Marine Field on Business Conditions and the Upbuilding of the American Merchant Marine

NEVER before in this generation have conditions in the marine field been more favorable for American shipbuilders and shipowners. Practically every shipyard in the country is filled to capacity with work at top prices for at least two years, and in most cases for a longer period. In almost every case the facilities of the yards for building ships have been enlarged, the working forces increased, new shops built and new machinery and equipment added. Several new shipbuilding companies have entered the field, a number of old and obsolete shipyards, idle for many years, are being put in shape for business, and on every hand large sums of money are being invested in the various marine industries with excellent prospects for profitable returns.

This unprecedented situation, however, is practically independent of any extension of the American merchant marine in foreign trade. Except for those vessels building for special industries whose interests are international and those building for foreign owners, the work now in hand is practically all for domestic use. It is to the development of the American merchant marine for foreign trade that thinking men are now looking for the future expansion of the shipbuilding and shipping industries in the United States. That this can be accomplished without direct government aid and encouragement is unbelievable, and events of the past eighteen months have shown conclusively that the time has come when definite action must be taken by Congress to overcome the obstacles that are keeping the American flag off the high seas.

SHIPPING AND SHIPBUILDING INDUSTRIES MUST BE PROTECTED

STEVENSON TAYLOR, PRESIDENT SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS

According to all reports, public and personal, the condition of business in the marine field is exceedingly prosperous, owing to the conditions existing among the other nations of the world.

No one can exactly foretell what the future prospects may be, so much depends on the conditions in Europe at the close of the present war. My faith in the future of the United States compels the belief that the American people will not be satisfied without a merchant marine under the Stars and Stripes—one commensurate with the importance of this nation.

The obstacles and hindrances in the form of unwise and class legislation, such as has prevailed during the past few years against railroads and shipping interests, must be removed.

Apparently a change in the sentiment of the people is becoming prevalent and will naturally be observed by legislators. The next general election will, without doubt, emphasize this change. If so, legislators will endeavor to conform thereto and they will repeal at least some of the objectionable features of existing legislation.

If, however, the existing shipping laws are continued until after the end of the European war, it is possible that a large proportion of the newly formed American merchant marine will seek relief by obtaining registration under the flag of some other nation whose laws help, not hinder, the promotion of shipping.

As to the financial side of this inquiry, if legislation is made to conform more nearly to the customs of other nations, at least to the extent of not making prohibitive the operation of ships on account of excessive cost, an acquaintance with the possibilities of a marine service will doubtless be made by bankers and capitalists so they will not be so chary of shipping investments. Such an acquaintance will result in promotion of larger shipping enterprises than have been heretofore proposed.

One other financial need is that of insurance, which should be provided in the United States to cover the building and operation of at least all of our own ships. This involves also a classification system which will deserve the confidence of the world. A movement is now on foot to provide such classification and insurance.

The shipping and shipbuilding industry should be protected as are other industries. It seems hopeless that any such legislation will be provided, so it can only be said, give relief from the unfortunate recent legislation and then let shipbuilders and shipowners alone for a few years, so they may meet the inevitable competition on a fair basis.

COMPREHENSIVE SUBSIDY LEGISLATION ADVOCATED

JOSEPH W. POWELL, PRESIDENT FORE RIVER SHIPBUILDING CORPORATION

At the present time every shipyard in every neutral nation the world over is full of business, and this condition will obtain not only so long as the war lasts, but for at least a limited time after peace again exists. What the situation will be thereafter no man can foresee, but the longer the war lasts and the greater its cost to the nations involved, the more nearly will the shipbuilding business in this country be placed on a plane of equality with the English and German yards. To count solely on this war as a means to restore our flag to the ocean is to leave this matter to fate.

The soundest and surest way to create a vigorous American merchant marine in overseas trade is to grant subsidies—and moderate amounts will suffice—to regular

liners from 14 knots upward on fixed postal routes, and subsidies to good cargo vessels sufficient to equalize costs of construction and operation between our ships and their foreign competitors. These subsidies should be conditional upon fitness for naval auxiliary service in time of war, and upon the building of the ships in American yards. This policy will promote our commerce and at the same time conserve the national defense. In a conflict with a great power the commercial shipyards of this country would be indispensable for naval construction and repair work, and as essential to the national safety as gun and armor plants and powder works.

The government can properly encourage shipowning and shipbuilding as it has encouraged manufacturing, but there is no more need that it should go into the shipowning or shipbuilding business than that it should embark in the making of steel rails or cotton cloth. Government participation in any business inevitably discourages private capital and enterprise from entering it, and consequently reacts harmfully on the development of business.

An intelligent revision of our shipping laws, under the guidance of men who have broad, practical knowledge of the shipping business, ought to be made a part of any effort to restore our merchant marine. But such a revision alone will not suffice, as witness the results of a suspension of the navigation laws on foreign-built vessels just admitted to American registry. The foreign officers and crews of these naturalized ships immediately demanded American wages and the American food scale and secured them, so that the cost of operation of these foreign-built steamers is exactly the same as the cost of operation of American-built ships.

The "free ship" policy, tried under the most favorable conditions, has already proved a failure, and the whole country must now recognize the need of comprehensive subsidy legislation for which free ships and the suspension or repeal of our navigation laws can no longer be urged as an alternative.

SEAMEN'S ACT GREATEST HINDRANCE TO THE MERCHANT MARINE

O. J. FISH, VICE-PRESIDENT AMERICAN SHIPBUILDING COMPANY

The present conditions of business in the marine field, as affecting the American Ship Building Company, are exceptionally good, due to the heavy demands on the Great Lakes' carriers, and also the possibility of salt water construction capable of St. Lawrence Canal passage.

Future prospects promise well, inasmuch as the demand for all kinds of steel products are taxing the ore fleet of the Great Lakes to the limit of their capacity, with no signs of abatement at present.

We consider the effects of the passage of the Seaman's Act the greatest hindrance to the permanent growth of the merchant marine.

All legislation should be the result of deliberations of a body of men familiar with the operation of vessels; for instance, a commission in whose hands the welfare and safety of passengers will be assured, as well as the development and upbuilding of a fleet which will be a credit to the country.

PRESENT DEMAND FOR AMERICAN MERCHANT VESSELS UNPRECEDENTED

WILLIAM A. DOBSON, NAVAL ARCHITECT, WILLIAM CRAMP & SONS SHIP & ENGINE BUILDING COMPANY

The present demand for merchant ships is beyond the experience of any American shipbuilder of the present generation. Every established shipyard is full of work, some new yards have been added to those already in existence, and the air is full of rumors of new yards to be established. The cause, to a large extent, of all this is found in the demand for war materials and supplies by the warring nations of Europe, who must look to this country to supply a great part of their present needs. All of this vast amount of freight must be carried to Europe in ships, which, owing to the destruction of many by mines and submarines, the internment of the vessels of Austria and Germany, and the commandeering of a large number of vessels under the British flag for use of the Government, are limited in numbers and do not begin to meet the demand for shipping facilities. The proof of this is found in the condition of the railways leading to every seaport adjacent to manufacturing centers. The tracks and sidings are congested with freight that can find no relief except through its transference to floating carriers. Hence the feverish activity of shipyards, spurred thereto by the insistent demands of shipowners to build ships for them. This condition has given to the shipbuilding business such a roseate hue that some new yards have been built and more are seriously talked of.

The question arises then, does the future hold in prospect sufficient business to warrant an increase in the shipbuilding facilities of the country? This question must be answered in part by the records of the past, and largely by a consideration of the cause of the present activity in shipbuilding.

There can be no reasonable contradiction of the statement, that while under ordinary conditions there would be at the present time a considerable increase in the building of new ships, yet by far the greater part of the present tonnage in course of construction is the direct outcome of conditions created by the war. Therefore, if the war has created such an expansion of shipbuilding, the cessation of hostilities will cause the shipbuilding boom to shrink to a condition more nearly normal.

Three factors will be involved in this shrinkage; first, the demand for war material will cease, and that for supplies will be greatly lessened; second, the vessels of the merchant marine of Germany and Austria will be released from their present internment, and third, the vessels now taken over by the British Government for transporting troops and supplies will be restored to the merchant marine.

In addition, the shipyards of Britain will be released from the obligation to build for the Government only, and may be able to underbid American shipyards for certain classes of vessels.

It is not believed, however, that the British shipyards will ever be able again to build ships as cheaply as in the past. This will be due to the fact that wages have increased largely throughout the Kingdom, and will not again find the lower rates which prevailed before the war.

The rise in the wage rates will so increase the costs

of material and labor as to more nearly equalize the cost of production in Great Britain and in this country. The result will be the building of more ships in American shipyards.

The five large shipbuilding plants on the Atlantic Coast are ample to take care of all American shipbuilding under normal conditions, especially as there seems to be a tendency to withdraw government shipbuilding from private yards and build our war vessels at the Navy Yards.

The wisdom, therefore, of establishing new shipyards is, to say the least, debatable. The policy of building war vessels in the Navy Yards will react upon the shipbuilding industry of the country, and possibly deprive the Government of some of the facilities it now has for a rapid upbuilding of the navy.

The experience of the past is fresh in the minds of shipbuilders, when, at some periods, but few merchant vessels were on order, and the yards were kept in existence by the contracts from the Government. These contracts had been taken at low figures as a choice between closing the yards entirely, or taking the government contract at such a figure as would enable the management to keep its force together. The result was that the United States obtained its vessels at the lowest cost of any of the great navies of the world. Should the present policy of building at the Navy Yards continue, the prospects are that some of the shipyards may in hard times be forced to close. As opposed to this policy, the Government by every means in its power should foster the shipbuilding industry. For the rapid expansion of our navy, which all are beginning to see is our chief defense, our shipyards must be encouraged to provide adequate facilities for building the present dreadnoughts. The day has passed when shipyards with ordinary equipment can build these enormous vessels and handle the heavy weights of armor, guns and turrets. Special appliances are necessary, and when provided, at large expense, should be utilized by the placing of orders by the Government, at such yards as are properly equipped. The system of the lowest bidder being awarded the contract for building is not always the best, either in the interests of the Government or the people at large. It would seem a better way for the Government to select such shipyards as, in its knowledge, possess the necessary equipment, skill and engineering ability to carry on its construction rapidly and intelligently, and place the contracts with them after agreeing upon a figure satisfactory to both parties.

An adequate merchant marine is a necessity for our commercial security, and it is indispensable in the event of war, as a source from which the Government can enlarge its fleet of colliers, transports, mine layers, and other vessels necessary for the minor but all-important services.

The best and most direct means of encouraging shipbuilding interests in the United States is by subsidy to steamship lines pure and simple. The nations engaged in ocean traffic paid in 1909 total subsidies and bounties amounting to $47,000,000 (£9,630,000). The United States in 1914 paid in mail subsidies $1,089,361 (£225,000).

"A word to the wise is sufficient."

LEGISLATIVE RESTRICTIONS MUST BE REMOVED

D. H. COX, NAVAL ARCHITECT, COX & STEVENS, NEW YORK

The present condition of business in the marine field is absolutely unprecedented, both in the volume of business and in the proportion of large sea-going tonnage being ordered. Practically all the building yards, both on the coast and inland are full up on orders covering deliveries extending over a period of two years. Further, we find that many of the present yards are enlarging their facilities for building, and several other building yards are being contemplated.

As for future prospects in the marine field, this, in my opinion, depends very largely upon the continuation of the present conditions existing abroad, and on legislation relating to the owning and operating of ships in this country. As long as the present existing conditions continue abroad, there is no doubt that, even with the handicap of present legislation, vessels can be most successfully owned and operated in the United States. At the termination of hostilities whether or not this condition will exist will depend greatly upon any legislation that may be enacted prior to that time. With the present legislative restrictions, it is doubtful whether American commerce will be able to compete with foreign commerce when competition is renewed.

The obstacles or hindrances that in my opinion must be overcome to insure the permanent growth of the American merchant marine are such restrictions as are now placed upon the American shipowner and ship operator, to his great disadvantage in competition with the owners and operators of foreign-owned or operated vessels.

EXPERT SHIPPING COMMISSION ADVOCATED

CAPTAIN GEORGE A. WHITE, GENERAL MANAGER HUDSON RIVER DAY LINE, NEW YORK

We consider the present conditions as generally exceptionally good for all freight steamers, but the passenger marine has had a bad year.

The success of the lines handling freight is, in spite of, and not by aid of, governmental regulations. As to future prospects—post bellum—the government may continue the strangle hold it has maintained and strengthened so long and make every marine venture a questionable gamble in which honest money and careful men may hesitate to subscribe, or the government may, by scientific, wise and constructive action, enable the marine brains and enterprise of this country to take advantage of the golden opportunity which is now knocking so loudly at our doors.

The La Follette Seaman's Union law should be repealed and a law harmonizing the London Conference with our conditions substituted.

Finally, it does seem the part of wisdom that the government, instead of the amateurish experiment of proposing to expend upwards of $30,000,000 on a visionary government-owned and operated merchant marine, should appropriate a few thousand dollars for the employment and maintenance of a commission to be made up of the best marine brains in these United States.

Let this scientific and business-like commission be patterned somewhat after such controlling bodies in such other nations as have made a success of their marine affairs.

Let the ablest naval architects and marine engineers

(two at least) be on it, also two captains of high standing, one in the salt water trade and one in the inland trade, one chief engineer, one admiralty lawyer, two successful operating officials, one from the salt water trade and one from the inland trade, one ship and engine builder, and two men from the operating crews, one in salt water service and one from the inland service.

Let it be the prompt duty of such a commission (non-partisan) in collaboration with the Department of Commerce, to revise our present jumble of marine laws and regulations, to review pending legislation, and to provide for a permanent commission of like character to safeguard our greater marine development from the nostrums of quacks and from the selfish, dishonest attacks of vote catchers.

The great present agitation for an oversea trade should not be allowed to blind us to the acute and crying present condition of our inland marine and of the passenger marine.

Our people enjoy and demand more and more the out-of-doors pleasures, and instead of being legislated out of existence, our passenger marine service should be treated at least as well as such service is treated by other more intelligent and more successful marine nations.

DEMAND FOR LARGE SEA-GOING VESSELS GREATER THAN EVER

ARTHUR D. STEVENS, PRESIDENT MERRILL-STEVENS COMPANY, JACKSONVILLE, FLA.

At present the demand for new ships seems to be beyond the capacity of existing yards to furnish them within reasonable time, although very attractive prices are offered. This applies particularly to ocean-going vessels of the larger class. For smaller craft the demand is not so great, so that the smaller yards are not yet crowded, but the congested condition of the big yards should have the effect of throwing into the smaller plants the lighter construction which the larger yards were glad to get under previous conditions.

The demand for large vessels is at present greater than ever, but it seems to me that should the European war be brought to an end there would be turned loose for commercial use such a large number of ships now interned or used for war purposes that the demand for new vessels would at least return to normal proportions, if not less than that. On the other hand the cessation of the war would necessarily result in a tremendous demand for docking and repairing, for each ship now either interned or in war service would require overhauling before resuming commercial service.

To enable the merchant marine to compete successfully with foreign bottoms it must be accorded sufficient privileges to overcome the greater operating expense imposed on it by our shipping laws.

I believe that the admission to American registry of foreign vessels with the provision that all repairs other than emergency work should be done in American yards, and the revision of existing treaties, allowing reduction of duty on goods imported from place of origin on American-built bottoms, would build up the American marine and develop our shipyards.

I am heartily in favor of giving to American seamen all the advantages possible, but, as stated above, there should be compensation in some manner for the extra burden of expense which is thus imposed on American vessels in order that they may successfully compete with foreign vessels that do not provide so abundantly for their crews.

ADEQUATE NATIONAL PROTECTION NEEDED FOR SHIPPING

WINTHROP L. MARVIN, AUTHOR OF "THE AMERICAN MERCHANT MARINE"

This great world-war has brought to the American people in a year and a half more realizing sense of the value of an American merchant marine than they could have acquired from orators and statesmen in a half century. For one thing, the war has demolished forever the specious plea so long familiar in the newspapers and Congress that if British and German ships could carry our commerce "cheaply" they ought to be allowed to monopolize the ocean, while Americans kept at home. War has mercilessly shown that "cheapness" purchased in this way may prove to be exceedingly dear when some foreign ships are interned and useless and others imperatively requisitioned for the service of their government. Every man of intelligence now knows that depending upon foreign merchant craft to convey our trade is almost as blind and suicidal as depending upon foreign soldiers and sailors to fight our battles and protect our flag. An American merchant fleet will hereafter be understood to be what it actually is—as indispensable to the nation in every part of it as an American navy or army.

The same course which has made the need of a strong merchant shipping so manifest has also fortunately made it easier of attainment. One hundred steel steamers of ocean-going size are now under construction in American shipyards—most of them designed for coastwise commerce, it is true, but all capable of overseas service if that is required. Nearly all of these are either tank or bulk-cargo vessels. Some yards are building several on the same designs. Standardizing of product and large and constant volume of production are now practicable as never before. For the first time, American ocean yards are now *manufacturing* ships, very much as locomotives and steel cars are manufactured—and the gain is certain to be great in economy and efficiency. There will inevitably be a narrowed difference in first cost between American and foreign ships after this war has ended.

This first cost of construction has unquestionably been one great and heavy handicap upon the growth of American ocean shipping. The present policy of free registry of foreign-built ships for international commerce is an experiment—a temporary policy certain to be modified or abandoned when the protectionist party returns to full power in the United States. There will be no need or excuse for "free ships" if the cost of shipbuilding in this country can be reduced on typical cargo craft to within 10 or 15 percent of the foreign figure, which after the war will undoubtedly be substantially higher than before. A difference so small as this would be counterbalanced by the superior durability of American-built ships and their privileges of employment in the coastwise service when not required for purposes of foreign trade.

One fact of the utmost practical significance which the

"free ship" experiment has developed is that the moment that foreign-built vessels accept the American flag their wage scale and cost of maintenance rise to the American standard. This fact is testified to by the Standard Oil Company, the United States Steel Corporation and other concerns owning foreign-built ships, which were given American registry under the Emergency Shipping Act of August 18, 1914. That act authorized the suspension by the President of the law requiring that the officers of these ships thus admitted should be American citizens.

But instantly the foreign officers and crews of these newly naturalized ships demanded and secured American wages. The ships were exempted by Executive authority from compliance with our measurement and inspection laws, but nevertheless the operating expenses of these vessels were immediately increased by the hauling down of foreign colors and the hoisting of the Stars and Stripes.

W. R. Grace & Company, New York shipowners, find that wages and food of a typical steamship under the American flag amount to $2,773 (£570) a month, as compared with $1,991 (£408) under the British flag. Nine steamers of the United States Steel Corporation have been transferred from British to American registry. The 373 members of these nine crews under the Britsh flag received in wages $12,478 (£2,560) a month. The 393 members of the same nine steamers under the American flag receive $17,537 (£3,600) a month—an increase of 40.54 percent besides an addition of 19 percent to the cost of food.

"Free ships" will not give us a great mercantile marine. "Free crews" will not. This has now been actually demonstrated by experience. What is needed is vigorous, positive National protection and encouragement. This is the real, vital heart of the question of our American merchant marine—and these are the things which the nation must do:

1.—Protect the cargo ships by a National subsidy sufficient to cover the difference in wages, food and cost of maintenance between American and foreign vessels. Make this subsidy large enough to cover, if necessary, any higher cost of construction of American-built ships, and make it conditional upon the fitness of the ships for auxiliary service as transports, fuel ships, ammunition ships, hospital ships, repair ships, etc., in case of war—when they should be placed at the disposal of the government.

2.—Protect the regular mail lines against the competition of foreign lines by a liberal amendment of the ocean mail law of 1891. All foreign governments subsidize regular steamship services. We must do the same with equal generosity and perseverance.

3.—Overhaul the navigation laws and regulations of the United States, striking out all that unnecessarily hinders shipowners and compensating shipowners for the cost of all exactions which their foreign competitors do not have.

4.—Encourage the creation of a great American survey and classification service as the foundation for an adequate system of American insurance for all American ships.

5.—Establish a Federal shipping board of trained and responsible officials, which shall be to our merchant marine what the Board of Trade is to the merchant shipping of Great Britain.

It is my profound conviction, based upon many years of disinterested study of the question, that protection—adequate National protection—along the lines thus indicated will make America the chief maritime, as protection long ago made her the chief manufacturing, nation in the world.

LAKE AND SEA-GOING VESSELS REQUIRE DIFFERENT STANDARDS

JAMES S. MORTON, PRESIDENT THE GRAHAM & MORTON TRANSPORTATION COMPANY, BENTON HARBOR, MICH.

As is customary on the Great Lakes, the steamships of the Graham & Morton Transportation Company were laid up about the middle of December and will remain out of business until some time in March. The business of the company last fall from October 15 until the close of navigation was good, and, judging from that and the general revival of manufacturing industries reported from nearly all sources, there is every indication that the 1916 freight business of the company will at least start off in a satisfactory manner.

As much cannot be said, however, of the passenger business of the company, which has always been heavy during the summer months, as recent legislation is going to have a very serious effect on the Lake excursion business. There must be modifications of some description of the La Follette seaman's bill to enable the Lake passenger excursion business—especially on short routes—to be maintained as in the past.

We would recommend that the great fresh water lakes be divorced from all salt water or sea-going requirements, as in a general way their interests are not at all alike. The construction of the vessels is entirely different, the routes are short and the runs of the different steamers are generally of a few hours' duration instead of several days.

PROMISING OUTLOOK FOR SHIPBUILDERS AND SHIPOWNERS

CHARLES C. WEST, GENERAL MANAGER MANITOWOC SHIPBUILDING & DRY DOCK COMPANY

There is no question but what present conditions in the shipbuilding industry are very favorable and the outlook for continuance of these conditions is promising. I can only say that I believe our commercial independence depends upon an adequate merchant marine. It should be built on a sound basis, capable of a steady and healthy growth, so that it will fully meet the needs of the country's foreign trade.

FAVORABLE CONDITIONS IN MARINE FIELD LIKELY TO CONTINUE

EADS JOHNSON, NAVAL ARCHITECT, NEW YORK

As to present conditions of business in the marine field, it seems unnecessary to add to the many evidences we have in the unprecedented volume of business at present being handled by all our shipyards and it is my firm belief that this condition will continue for some years to come.

The future is assured, for it seems to me that with the

present growth of shipbuilding in this country, in spite of the serious legislative obstacles such as our navigation laws and the short sighted policy of our government, we *will* have a merchant marine as long as we are financially able to support it. With so many alien interests attracted to the necessity of floating property, it is doubtful if we shall ever go back to the financial hardships of the past.

The only form of legislation that can be recommended at the present time for the continued upbuilding of our merchant marine is that which the present administration has applied to Mexico—"watchful waiting." There are so many obsolete laws that must be redrawn and so many new laws that must be made obsolete to meet new conditions brought about by the present increase in our merchant marine that we shall have to wait for these in due course. New blood is needed in every department directing the government policy towards shipbuilders and shipowners and the people will have it.

It is my hope that the change will be made soon after the next Presidential election.

SHIPBUILDING ON THE GREAT LAKES NOW AT HIGH TIDE

HARVEY C. BEESON, CHICAGO

Shipbuilding on the Great Lakes is now at high tide and all steamship owners are more than optimistic as regards next season's business.

Personally I have no hesitation in prognosticating a movement of iron ore on the Great Lakes for the season of 1916 of 57,000,000 tons. In the past 25 years I have never missed on this estimate, with the exception of one year, and have generally set the amount below the total tonnage reached. The basis of this estimate, therefore, is reasonably sound.

Furthermore, in relation to lake freight rates on coal, grain and lumber for 1916, it is safe to say that they cannot be otherwise than high as compared with any rates paid to date, for the simple reason that the volume of freight to move in these commodities will be increased and the facilities for moving them have steadily decreased.

The anxiety to move ore will keep out considerable tonnage that formerly carried coal. Even the older class of wooden bottoms on the Great Lakes will be good property before the season opens.

AMERICAN TRADE MUST BE CARRIED IN AMERICAN BOTTOMS

J. MURRAY WATTS, NAVAL ARCHITECT AND MARINE ENGINEER, PHILADELPHIA

Every patriotic American must question the policy that has allowed this country to become dependent on foreign shipowners to carry her overseas commerce. The present condition of business in the marine field is an abnormal one, caused by the scarcity of ships available for our growing export trade.

For the last ten years we have been constantly preaching the cause of the American merchant marine, claiming that American trade must be carried in American bottoms. Our experience has shown that trade follows the flag. Take Central and South America. These countries have been supplied largely by German vessels, with German consuls to look after their country's interests, and German banks to make the necessary credit arrangements on the spot.

This firm has designed many yachts and commercial vessels for these countries and often our business arrangements are carried on through Berlin or London, and machinery and equipment sent over to Europe and back across to South America, as we had no ships to make prompt delivery direct from this country.

Naturally South Americans prefer to deal with a country when they can see the visible power of that nation in the flags flying from the fine ships, with a magnificent export trade system behind these ships, like Germany. Up to the last year the average business man took less than no interest in the American merchant marine. The general reply to any appeal to interest them in it was that if the foreign ships could carry our products cheaper than our ships could there was no necessity of having American ships.

When it was explained to them that England, France, Germany and Japan had built up their merchant shipping by subsidies and protective legislation, there was generally a howl that this country should not pay subsidies to enrich one class, namely, the shipping men. This cry came especially from the Middle West, where the people were selfishly against any monetary aid for the coast States. They did not realize that any help to commerce benefited them, whether it was on land or sea.

They forgot that the trans-continental railroads were subsidized enormously by land grants and monetary aid amounting to millions, direct from the government. No one has grudged this aid to carriers on land, as it has been of enormous help in building up the prosperity of the country, but shortsightedly and selfishly they refuse to consider a far smaller subsidy to American sea carriers, not realizing that it would benefit the whole country to an almost greater extent.

Congress since the Civil War has apparently done its best to legislate the American merchant marine out of existence, and the result is that we have practically no American deep sea ships, and the farmers and mine owners cannot deliver the grain, cotton, coal and manufactured goods of which they have an enormous surplus, and for which there is a constantly increasing demand. The very few ships that we have available in spite of this policy of ignorance and prejudice have greatly increased their rates, but even so the demand for tonnage space far outruns the supply.

Besides the ignorance displayed on marine subjects, the coastwise trade has had to struggle against the power of the railroads, who have done all they could to stifle competition, using their dock and terminal facilities to force acceptance of their terms, and getting control of competing canals and steamship lines, and not hesitating to influence legislatures to attain their ends. The revelations in the cases of the Rock Island and New York, New Haven & Hartford Railroads show what railroad management can be.

The case of the Panama Canal tolls is fresh in our memory. The government was pledged to give our coastwise shipping freedom from tolls. This did not suit the great trans-continental railroads, and their influence and that of the Canadian roads were sufficiently great in the lobbies of Washington to have the law repealed and a sufficiently high toll placed on our shipping to keep us from building many ships for this trade, and so seriously competing with these roads.

The latest blow to our shipping is the La Follette bill, jammed through Congress by those truckling to the labor

vote. This bill conflicts with our treaties with all the foreign maritime countries, has destroyed discipline on our ships by encouraging desertion of sailors, and is so palpably foolish that now it has driven our ships off the Pacific. It is no longer being rigidly enforced against foreign ships.

It has, however, been in operation long enough to allow the heavily subsidized Japanese lines to capture all our Far Eastern trade, with the result that our exporters are suffering heavily from arbitrary rates imposed by Japanese shipping owners on all but Japanese goods.

While during the war and for a short time afterwards our ships and shipyards will be busy, the foreign commercial fleets will soon again be competing with us, and our American merchant marine will again fall into innocuous desuetude, as foreigners can build and man ships cheaper than we can, and besides in many cases their ships are subdsidized and given special advantages by their governments.

In the famous cruise of our sixteen battleships around the world we had to rely on English, German and Japanese ships to carry our coal and supplies. In the possibility of our being embroiled in a sudden war we have practically no ships to act as auxiliaries, and no seamen trained on American deep-sea ships to man the auxiliaries, if we could get them.

The American people will learn by experience that their country as a whole needs an American merchant marine in foreign trade. There must be American-built ships, so that at all times our shipyards may be in shape to build and repair ships. The more ships we build, the cheaper they will become in spite of our high cost of labor, and we will develop yards like that of Harland & Wolff, who have standardized their output, so their ships are manufactured like stock motor trucks, all the ships being practically of the same type with identical fittings, and varying only in load-carrying ability. It is important that the actual carriage of imports and exports should be under our own flag, so that the nation shall have a well-organized merchant marine of its own, instead of relying on an unstable supply of foreign ships.

Our early shipping policy inaugurated by Washington and continued up to the time of the Civil War was to encourage shipowners and builders. Since that time, owing largely to ignorant legislation, protection was given to all industries except the shipping industry. That industry, alone and unprotected, with laws making it far more expensive to run our ships than foreign ships, has naturally succumbed, so that now instead of carrying 80 percent of our foreign trade it carries less than 10 percent.

At this time we are paying at least $50,000,000 a year to foreign shipping lines to carry our passengers and goods. To regain our former prestige and build up our deep sea merchant marine, the government should make up to citizens of this country who are willing to invest in shipping the difference between the cost of building and running our own and foreign ships, not to benefit a class of shipowners, but for the benefit of the whole country's trade in time of peace, and her safety in war.

To get a merchant marine we must first get all such senseless and obstructive laws as the La Follette bill repealed, grant subsidies to our ships, and also allow on cargoes carried by them reductions in import duties and tonnage taxes, provided that such reductions will not interfere with commercial treaties with foreign nations.

AMERICAN SHIPYARDS FILLED WITH WORK AT TOP PRICES

G. W. DICKIE, SAN FRANCISCO, VICE-PRESIDENT SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS

If, two years ago, any one had predicted the actual conditions that prevail to-day in the overseas carrying trades of the world, few would have given any credence to his prophecy, yet in fact, in a general way, those of us who for the past twenty years have been trying to make the people of this country realize the effect that a European war would have on our foreign carrying trade have been through all these years predicting the very conditions that now prevail.

As a direct consequence of the general indifference to foreign trade this country now finds itself in no condition to profit by the withdrawal of a considerable part of European shipping from the regular lines of commerce. About a year ago the pinch in shipping facilities began to be felt; shipping houses began to look to United States shipyards for help and those who got their orders placed first have been able to choose between selling ships under construction at a handsome profit or retaining their ownership and operating at very remunerative freight rates. Now all our shipyards are full of work at better prices than they ever had before and have orders booked for two years ahead, yet the need for ships is more urgent than ever.

This condition, which in American shipbuilding is very abnormal, is due to the fact that shipbuilding for mercantile purposes is practically stopped in Great Britain, France and Germany, where the machines and operatives are put to more directly offensive and defensive uses. Mr. Balfour stated in Parliament recently that in order to encourage an industry which had practically almost ceased since the beginning of the war, namely, the building of merchant ships, a clause was put in the munitions bill which would enable them to say that shipbuilding of this kind was carried on as war work, and war work he believed it was. He hoped that the House would let that bill through, as every day that passed meant a day's delay in the completion of some merchant ship. Whether this helps or not, the present dearth of ships will continue until the cessation of war diverts tonnage there used auxiliary to various hostile operations to the peaceful pursuits of ordinary times. Until that time comes the American shipbuilder will have all the work his yard can turn out at prices that should yield handsome profits.

Beyond that the future of shipbuilding in this country will depend upon the chance of securing favorable legislation where that can do any good towards enabling our shipbuilders to hold permanently to the business they have secured under and on account of conditions not of their own making. When the present abnormal condition is removed by the return to legitimate trade of diverted tonnage, our shipowners will seek tonnage where it can be had cheapest. Part of any preparedness programme must be the establishment of a merchant marine built, owned, and operated by citizens of the United States. It does not so much matter who owns the ships so long as they are built here and operated under the United States' flag ready for service when the defense of the country requires their aid. Heretofore, measures which have come before Congress have not been treated according to their merits nor have they been discussed fairly. The questions involved are not of a nature readily understood by the average orator.

Representative Curry now has a bill in the hands of the

committee on merchant marine and fisheries. This bill, should it become law, would lay the foundation for real constructive legislation. If the commission it proposes to bring into existence were composed of the right kind of men representing all the interests connected with the merchant marine, it would become the source of all legislation dealing with that important branch of government and would establish a steadily growing merchant marine in a reasonable time. It would be the duty of the commission to prepare and present to Congress the measures necessary to produce the desired result. Such legislation would naturally grow out of the work of the commission. The object of the legislation and other work of the commission advocated by the Curry bill would be to place the American ship on an equality with the ships of other nations engaged in the same trade. The commission would need the confidence of the Government in all its branches and should be fully backed up by the determination of the people to have a standing on the sea equal to their power and influence on the land.

NECESSITY OF DEVELOPING THE STATE NAUTICAL SCHOOL

COMMODORE J. W. MILLER, CHAIRMAN BOARD OF GOVERNORS, NEW YORK STATE NAUTICAL SCHOOL

For the past thirty-eight years, during which there has been a general apathy regarding the development of marine commerce, New York has continuously maintained an institution of high standard for the education and training of officers for merchant vessels. For this purpose a ship, together with officers of high intelligence, has been provided by the Navy Department.

Prior to 1913, the city of New York, under its Board of Education, met all other expenses. Since that date the schoolship has come under the direct jurisdiction of the State of New York, and to-day the young men of the lake region as well as those from the Atlantic coast are seeking admission in large numbers. The schoolship *Newport*, at present provided by the Navy Department, is too small to receive the many applicants who now apply.

Realizing the present critical condition, when the whole country is alive to the necessity of an increase in our merchant marine, and when officers must be supplied at an early date for such a development, the Board of Governors has been in negotiation with the Navy Department for a larger vessel, but has been advised that none is available. To secure such a vessel would require the expenditure of about $100,000 (£20,500). On March 4, 1911, Congress passed a statute carrying a proviso for an appropriation of $25,000 (£5,125) per annum for each State supporting a nautical school, but since its passage no appropriation has been made to the two States (Massachusetts and New York) having such schoolships. The total amount, if it had been allowed to date, would have been $200,000 (£41,000). In view of this it seems that steps should be taken by all interested in sea power to procure an appropriation from Congress of at least $100,000 (£20,500) for the State of New York to purchase, if necessary, a ship to replace the *Newport*. If deemed wise, the authority for such purchase could be vested in the Secretary of the Navy, with the understanding that the vessel would be turned over to New York, but liable, of course, to be taken up by the Navy Department in case of a war crisis.

If the American merchant marine is to be rehabilitated, we must have trained American officers and seamen to man the ships. It would seem, therefore, only necessary to state the fact that at a cost of $100,000 (£20,500) the State of New York alone could graduate each year about one hundred men thoroughly equipped to perform their duties on board an increased merchant fleet. No further argument ought to be needed on this subject, especially at a time when stalwart young men, full of the old American sea spirit, are ready to follow the sea if the chance only be given them.

DEVELOPMENT OF A NATIONAL SHIPPING POLICY

ROBERT DOLLAR, PRESIDENT THE ROBERT DOLLAR COMPANY, SAN FRANCISCO

In a paper presented before the third National Foreign Trade Convention at New Orleans, La., on January 27-29, Captain Robert Dollar, president of the Robert Dollar Company, had the following to say regarding the American merchant marine:

Various remedies have been proposed for the solution of our merchant marine question. The proposals now figuring most prominently before the public may be summed up under three heads: First, Government ownership; second, equalization of operating cost, under whatever name may be given to the direct assistance of the State to shipping; third, the development of a truly national shipping policy along lines recommended by a permanent nonpartisan shipping board after business-like consideration of the country's real shipping necessities.

Government ownership is a proposition to pay a subsidy of far greater scope than any subsidy policy that has as yet been proposed; for any subsidy contract is necessarily limited as to the amount of money which may be disbursed to the shipowners undertaking the subsidized services, whereas, with the Government itself operating the ships on that extravagant scale with which all business men are familiar, there is no limit to the deficit that may be accumulated by the ships performing the services yet to be announced.

This much, however, can be said: The Government proposes to embark in a business which normally costs 25 to 35 percent more to conduct under the American than under foreign flags. Unless the Government can perform the service more cheaply than private enterprises, it must incur deficits to be met out of the public treasury. The vessels cannot be leased to private companies unless private companies can operate them profitably.

In other words, the only way the Government can induce private companies to operate those ships under the American flag, under the conditions prevailing before the war, and which surely will prevail after the war, is to make the leasing price low enough to offset the excess of operating cost over that of our competitors. Somebody must pay, and under the Government ownership principle it will be the taxpayer. The increase of our shipping in foreign trade will depend upon the willingness of the taxpayers to increase the appropriations to be made for the new construction, and, possibly, continued deficits in the Governmental shipping policy account. In other words, the shipping policy, requiring continuing and increasing

appropriations, will be under debate at each session of Congress. It is easy to see how sectional and political considerations may complicate any shipping progress dependent upon the Government ownership policy.

What better means could be found of ascertaining the needs of our shipping in the matter of cost equalization than through the establishment of a non-partisan Shipping Board, composed of practical men who thoroughly understand the shipping business, that would undertake an unbiased study of the question, Congress, in the meantime, refraining from increasing its legislative labors on the subject of shipping until it could be guided by the findings of such a Board.

The National Foreign Trade Council, in its report on the merchant marine question, adopted at the meeting held in New York, on September 23, 1915, advocated the establishment of a permanent Shipping Board composed of five members experienced in shipping and foreign trade, which would recommend to Congress such revision and modernization of all United States laws relating to shipping as might be deemed necessary, while permanently discharging all the functions of the Federal Government relating thereto. What better guide to the education of public opinion along rational channels in shipping matters could be constituted than by means of such a shipping board as was proposed by the National Foreign Trade Council?

If we desire to elevate American shipping to the dignity to which it is entitled by reason of our enormous foreign trade, our national wealth and the extent of our coasts and possessions, let us consider the problem in a manner worthy of its importance, so as to lay the foundation of an evolution that may bring us in line with all those nations that since the remotest days of antiquity have placed their utmost ambition in the possession of the reins to the car of Neptune.

FACTS CONCERNING THE SEAMEN'S ACT

H. H. RAYMOND, PRESIDENT MALLORY STEAMSHIP COMPANY, NEW YORK

The La Follette seamen's act is one of the most radical pieces of legislation that has been enacted by the United States Congress in many years.

Section 1, providing that on all merchant vessels of the United States of more than 100 gross tons, except those navigating rivers, harbors, bays or sounds exclusively, the deckhands must, while at sea, be divided into at least two, and the firemen, oilers and water tenders into at least three watches, which shall be kept on duty successively, merely makes statutory what has been customary, except that on short runs on the Great Lakes and elsewhere where the practice has not been pursued, a change is made obligatory. The act does not discriminate in this matter between a voyage to Bombay or Australia and a trip outside the Hudson River to the fishing banks or on one of the short daylight excursion routes, where such a distribution of the hours of labor will necessitate the doubling of the deck crews and the trebling of the engine room forces. It will also be particularly expensive on vessels making landings at small ports in sparsely settled communities along the Pacific coast.

Section 10, prescribing regulations for life-saving equipment and structural modifications of ships, and providing for certified lifeboatmen, has been taken almost bodily from the recommendations of the London Conference on Safety of Life at Sea, which, had not the war intervened, would doubtless have been adopted by all maritime nations. These are admirable for the ships for which they were intended, viz., trans-oceanic craft. By the terms of this act, however, they have been made applicable, with but slight modifications, to the whole of the shipping of the United States, including the coastwise, bay, sound and Great Lakes shipping. This will necessitate extensive alterations not contemplated when those vessels were designed and constructed, and their structural stability may be seriously affected.

Section 15 compels the owner of every vessel of the United States and every owner of a foreign vessel while in the ports of the United States to pay to the seamen on demand one-half of the wages due them at every port, providing this demand is not made before the expiration of nor oftener than once in five days. Is it reasonable to expect that foreign nations will meekly consent that agreements made with the seamen in their own country shall be nullified as soon as their ships reach an American port?

Section 16, providing that 75 percent of the crew, in each department of every American ship, and of every foreign ship coming to an American port, must be able to understand any order given by the officers, has had the effect of eliminating six large American ships from competing with the existing Japanese steamers on the trans-Pacific trade. These vessels carried American officers on the deck and in the engine room, but their crews were Chinese. It was by this means alone that they were able to sustain their trans-Pacific service for so many years. The petty officers among the crews were bi-lingual and able without difficulty to communicate to the crews the orders given by the American officers. To insist that 75 percent of a Chinese crew shall speak English sounds the end of the American ship as a competitor in the trans-Pacific trades. Any expectation that this requirement will lead to the creation of a large body of American seamen speaking the language of the officers of the American ships is absurd. Furthermore, experience has not proven that this requirement will be conducive to the safety of life at sea.

Section 17 provides that every American vessel and every foreign vessel clearing from an American port must carry 65 percent able seamen. The requirements for qualification for an able seaman's certificate are three years' service on deck at sea for ocean service and eighteen months' service on the Great Lakes, except that where an applicant can pass an extra examination one year's service will suffice, provided such one-year men shall not form more than 25 percent of the 65 percent able seamen. The term able seaman belongs to the days of the sailing ship. The work performed by the deckhands aboard a modern steamer is of the most ordinary kind of unskilled labor. To insist that it requires three years' experience to acquire facility to perform such simple duties is farcical, the general opinion of practical steamship men being that as many months at most is amply sufficient. The sole effect of this provision of the act will be to restrict the number of men available for this kind of work, which no legislation should seek to accomplish. This provision of the act was considered by the International Conference on Safety of Life at Sea and was almost unanimously rejected, the conference considering that their recommendations providing for safety appliances and certified lifeboatmen were amply sufficient for this purpose and that it was ridiculous that a deckhand should have an additional certificate as an able seaman.

An Analysis of the Shipping Bill

Salient Features of the Administration Measure for Upbuilding the American Merchant Marine

By "Old Scotch"

It will be taken for granted, I think, that there is no argument but that the United States needs a vast increase in its own shipping for the foreign trade. We can not continue long to deliver our manufactured products in the delivery ships of our principal competitors for the world's trade. We will, of course, continue to sell those of our articles of export where little, if any, real competition exists. These non-competitive articles, such as wheat, petroleum, cotton, etc., are drawing largely on our natural resources, and, while furnishing work for our farmers, produce but little business for the vast army of our citizens employed in manufacturing. The development of our foreign trade in manufactured articles is of primary importance; the merchant marine which we need is but contributory.

Federal Aid Needed for the Merchant Marine

It is now generally recognized that to build up our merchant marine, some help is necessary from the federal government. We must not lull ourselves with the belief that the temporary activity in our shipyards marks the dawn of the much dreamed of restoration of our foreign shipping. Far from it. If we take discerning notice of the ships now building we will find that, aside from new coastwise steamers, a great number of tankers and a respectable showing of ships for foreign buyers, there are but few now on the stocks for the foreign trade.

The bill now pending before the House of Reprensentatives represents in its entirety more constructive and beneficial legislation in the making than has ever yet been proposed towards the much desired revival of our foreign shipping. To those interested in the subject I would say, do not too hastily form conclusions concerning this measure. The much-heralded bugaboos of Government ownership and Government competition with private interests become very remote when the true intent and meaning of this bill is analyzed. The three most important features of the measure are the formation of a Shipping Board to have general supervision over maritime matters; the creation of a fleet of naval auxiliaries and army transports, and the utilization of the fleet thus created in the extension of our foreign commerce in peaceful times. Looking at these objectives more closely we find the following:

The Shipping Board

The Shipping Board is to be composed of five members, two of whom are to be the Secretary of the Navy and the Secretary of Commerce, ex-officio; the other three members are to be practical shipping men, thoroughly conversant with ships and maritime commerce, one of whom is to be designated as chairman by the President. The salary of each of the three practical men is to be $10,000 (£2,050) per annum, and it is provided that they can engage in no other occupation, thus being able to devote their entire time to the Shipping Board. With certain exceptions, all the employees of the Board are to be taken from the civil service lists. Primarily the Board is authorized to construct in American shipyards and navy yards, or to purchase or charter vessels of a type, as far as the commercial requirements of the marine trade of the United States will permit, suitable for use as naval auxiliaries and army transports. For this purpose the proceeds of the sale of $50,000,000 (£1,025,000) of Panama Canal bonds is placed at the disposal of the Board.

Naval Auxiliary Fleet

In ordinary times this amount of money in American shipyards will produce a fleet of vessels of approximately 500,000 gross tonnage. The Chief of Operations of the United States Navy states that that amount of shipping of this kind is absolutely essential to place the navy in a state of preparedness. All persons familiar with shipping will remember the humiliation we were subjected to when our fleet of battleships made its celebrated passage around the world by being compelled to charter foreign colliers to supply the fleet with the necessary fuel and provisions. Such auxiliaries are as important to success in naval operations as the fighting ships themselves.

In times of peace, however, but a small portion of such auxiliaries are necessary for the operations of the navy, and under ordinary conditions the greater part of such a fleet would be tied up in idleness at the navy yards and become a constant source of expense for deterioration and care taking. What more logical use therefore could be made of such a fleet than to charter these vessels to shipping men for the building up and extension of our foreign trade? The question which will naturally be propounded by prospective charterers will be as to how they can be operated in competition with foreign vessels. Just here is where the government help will be apparent. We all know that the principal items of operation are interest on capital invested, wages and food of crew and the cost of fuel.

Savings on the Investment

Let us look on these three principal costs with an analytical eye! We will find that the government with its credit back of it has borrowed the money to construct the ships at about three percent per annum; private interests would be extremely fortunate to borrow money for similar purposes at six percent. Depreciation plays no favorites, and would be the same for all ships, government-owned or otherwise. There would, therefore, be—as the government will not be in the shipping business for a profit—a differential of three percent in overhead charges on these leased ships immediately apparent. Fifteen thousand dollars (£3,080) annual saving on a five hundred thousand dollar (£102,500) ship would be no inconsiderable item in the balance sheet of a shipping firm.

It is almost needless to remind shipping men of the great economies to be gained in operating a fleet of modern vessels, equipped with the latest types of marine propulsion, in competition with the average of all ships built in the last twenty or twenty-five years. Those are the ones with which the American fleet will have to compete. Our foreign rivals are handicapped with this old equipment, and there is but little danger, owing to their value, of a wholesale consignment of these vessels to the scrap heap. We will have a decided advantage with the proposed new fleet for a number of years, as we can thus capitalize our delinquencies in shipbuilding heretofore into a decided asset. It is needless for me to remind marine men that the

average saving on fuel with the modern type of geared turbines over the average reciprocating engine afloat today is as high as thirty percent, and with certain internal combustion engines even greater than that. The use of oil fuel, of which this country controls two-thirds of the world's output, opens up another avenue of saving; when carried in hitherto unused double bottoms it adds from five to ten percent to the freight earning space. It requires but little calculation to prove to your own satisfaction that the combined savings due to cheap capital, reduction in consumption of fuel and added freight space will easily offset the cost of increased wages and better food incident to American ship operation.

Creation of a Naval Reserve

In order to create a naval reserve with which to man these auxiliaries and to act as a feeder to the regular navy, the bill provides that all officers and men serving on the ships thus created, who are American citizens, may be enrolled as members of the reserve, and as a retainer for thus holding their services in readiness for this country's demands in war times, they are to receive compensation which will amount practically to one month's full wages for a year's enrollment. In this way alone it is possible to overcome at least ten percent of the differential between American and foreign wage rates—a decidedly favorable item in the cost of operating these naval auxiliaries by private management.

Not alone are the new ships created by the proposed act to be placed under the Shipping Board, for the bill further provides that all the existing naval auxiliaries, army transports and Panama railroad ships which can be spared are to be placed under the Board's control and leased to the best advantage. In these days of freight embargoes by the railroads, on account of lack of ships, enormous freight rates and congested conditions generally, the immediate leasing of government ships with a combined freight capacity of sixty to eighty thousand tons would be no small boon to our exporters.

Government Ownership a Last Resort

The twin bugaboos of government ownership and operation will be found to dwindle down to a section of the pending bill which provides that the Shipping Board, if in its judgment it becomes necessary to do so, may form a corporation or corporations and purchase not less than the majority of the stock thereof, to operate and maintain a fleet of vessels in the commerce of the United States. This procedure would not, it is but fair to assume, be resorted to, unless no private concern would charter the vessels or otherwise provide efficient means of transportation on certain routes where the commercial interests of the country demanded that such be provided.

Much business has been in the past lost to the United States because our manufacturers, in competition with foreign rivals, have been unable, owing to the existing restrictive laws, to guarantee quick deliveries. For example, if a railroad in the Argentine should be in the market for a large consignment of steel rails, and invited tenders from firms in England, Germany and the United States, and stipulated that quickness of delivery would be an important factor in the award of the contract, while the American bidders might be able to roll the order as expeditiously as their foreign rivals, they would not be allowed under existing laws to arrange with the railroad to the sea coast to have the delivery made at the port of departure for a specific sailing of the vessel chartered to deliver the rails. The shipment by rail would have to take its regular turn with the shipment of all other classes of freight, the delivery of which is always problematical. Again, if the competition in price of the rails was very close the railroads would not be allowed to depart from their scheduled rates for all shipments of that particular class of freight. The German competitor could secure specific sailings for his cargo, and when necessary to win out in the competition the railroads to the sea could aid in securing the order by reducing the usual freight charge. The pending bill provides expressly that both specific sailings and preferential rates may be offered by the railroads whenever such procedures are necessary in order to secure foreign orders for goods of American manufacture. The value of such concessions should not be underestimated when the shipping bill is considered.

Licenses to be Required for all Vessels Entering American Ports

The Shipping Board will have control to a large extent of the rates to be charged in all water borne interstate and foreign traffic. It might be asked how this control will extend to foreign vessels. While of course there can be no direct jurisdiction over vessels of other countries engaged in our foreign trade, it is provided that all vessels, both domestic and foreign, must first obtain licenses from the Shipping Board before they will be allowed to enter and clear from our ports. The Board is empowered to establish such rules and regulations as in its judgment may be necessary, and no corporation, firm or individual will be granted a license unless they agree to abide by these rules and regulations. One need not stretch his imagination very far to conceive that these rules will prohibit unfair competition by rate cutting, or that the so-called foreign "fighting ships" will not be allowed to compete with our own vessels.

Owing to the disturbed conditions abroad, a considerable fleet of foreign vessels, the majority of whose stock was owned by American citizens, took refuge under our flag, owing to certain concessions made in our navigation laws by Congress. Should this bill pass none of these vessels, and no other vessel now flying the American flag will be allowed to be transferred to any foreign registry without the approval and consent of the Shipping Board. During our Civil War many of our merchant vessels passed to foreign registry for protection on the seas and were never allowed to come back. This clause of the pending bill will, in a manner, compensate for some of the losses of our tonnage at that time, and, furthermore, be in conformity to the prevailing practice of our leading foreign rivals.

American Ships Available for Naval or Military Purposes

All vessels leased, chartered or sold by the Shipping Board must, under the terms of the bill, be held in readiness to be taken over by the United States, absolutely or temporarily, for naval or military purposes, should the occasion arise to make such procedure desirable on the part of the Government. The consideration must be the fair actual value if purchased outright, or a reasonable rental, based upon normal conditions, if taken but temporarily. This will prevent a repetition of the "gouging" to which our Government was subjected at the outbreak of the Spanish-American War.

There need be no fear of any unusual international complications if any of the vessels leased by the Government, or owned wholly or in part by the United States and operated in strictly commercial business, should be seized or hindered by belligerent nations, as it is expressly provided in the bill that all such vessels shall in all respects be subject to all laws, regulations and liabilities governing merchant vessels.

It is also expressly provided that only such of the vessels controlled by the Shipping Board as may have been constructed in the United States can be used in the coastwise trade, and particularly the trade between the Atlantic, Gulf and Pacific Coasts.

Much complaint is heard concerning our existing navigation laws; to their alleged improprieties and shortcomings are attributed many of our shipping ills. No board now exists to investigate them in a broad-gaged manner. This bill especially empowers the Shipping Board to make diligent investigation into the navigation laws of the United States, and to furnish the President with such information and data as will enable him to recommend to Congress what remedial legislation may be necessary for the promotion and development of the American merchant marine.

Thus we have the much talked of Shipping Bill in all its phases. Consider it from any angle you may, it presents the most feasible and comprehensive plan yet devised to accomplish the purposes for which it is intended. We are at the threshold of a grand rearrangement of the world's business, and particularly of the business of sea transportation. England, France, Germany and Japan own over three-fourths of the world's shipping; in each of these great nations its merchant marine is now under governmental supervision. The time for the United States to act is now. No longer must we sit supinely by, some arguing for the impossible—the attainment of direct subsidies—others contending for this scheme and that scheme, and all bemoaning the fact that we have so few vessels with which to develop our foreign trade. We have almost within our grasp a clear-cut, definite and beneficial policy for our maritime development. If we do not embrace this opportunity, what have we then to contemplate?

The writer has spent many years in the study of merchant marine conditions; he has had unusual opportunities to observe at close range the tendencies of legislative matters at the national capital; he early embraced and tenaciously clung to the doctrine of direct subsidies until he saw the chances for such legislation pass into oblivion; he is writing these views solely from the standpoint of patriotic Americanism, as he has no other interest in the matter. In conclusion he predicts that, unless this measure is passed substantially as it is drawn, and at this session, there are but small hopes for helpful merchant marine legislation for many years to come.

A New and Constructive Policy for Upbuilding the American Merchant Marine

Formation of Federal Shipping Board the First Step—Expansion of Foreign Commerce—Provision for Naval Auxiliaries

BY BERNARD N. BAKER
Former President of the Atlantic Transport Company

Little or no difference of opinion exists among the people of the United States on the general proposition of restoring our flag to the seas. It is freely granted that the differences as to how this may be achieved are wide and apparently irreconcilable, but upon the broad question of whether we should or should not have a merchant marine we are in perfect accord. It is true that there is a group of men who honestly doubt if our shipping can be re-created without direct subsidies; another group that holds to the theory that all navigation laws must be overhauled if our shipping is to prosper, and still another group that insists that government ownership and operation of ships is the only means whereby ultimate maritime success can be achieved.

There would appear, offhand, to be no common ground upon which these men might stand. They are undoubtedly far apart in their views, and it might seem to be an impossible task to reconcile convictions so divergent, to offer a merchant marine program which would embody the best thought of all conflicting elements. Such a plan, however, is not impossible. On the contrary, it is decidedly possible.

Creation of a Shipping Board the First Consideration

There is, under existing circumstances, but one defensible method of dealing with all the questions involved in the establishment of a merchant marine under the American flag. This centers about the creation of a Shipping Board, endowed with powers sweeping enough to meet every issue, and with money enough at its disposal to carry into effect any policy which it may find necessary to adopt. The establishment of such a Board is an imperative necessity and should be the first consideration of Congress, when that body approaches our marine problem. All other questions may be subordinated to it or, rather, may be merged with it.

Commission Regulation Not an Untried Experiment

If sufficient authority is given a Shipping Board, it may be relied upon to go to the very root of our difficulties, to study the demands of our commerce and the needs of our navy, to weigh the claims of our labor, and, resolving the results into a concrete whole, to give the country an effective administration of our over-seas shipping industry. There is no other feasible way in which the government can, in the present circumstances, render assistance to this interest. The work should be done by an expert body of men enjoying the confidence of business and labor in equal measure, and entrusted with the power to move in the direction which will best serve the national interests.

Nor is the commission plan of handling special phases of the government work a new idea. It is not an untried experiment. We have made use of these bodies for more than twenty years, and have delegated more and more power to them as each successive Board has demonstrated its usefulness. Only an arrant iconoclast would dare propose the abolishment of the Interstate Commerce Commission, the Civil Service Commission or the Federal Reserve Board. Each of these bodies has a fixed place in our system of government, and long ago each of them vindicated the judgment of its creators. The proposal for a Shipping Commission is but another step in the

same general direction, another move toward competency in handling a definite piece of work demanding the skill and experience of specialists.

Such a Board as is here suggested should devote itself primarily to the expansion of our commerce through the establishment of steamship lines and to the equipment of our army and navy with shipping auxiliaries by the purchase or construction of a fleet of merchantmen. All else might be properly regarded as detail. The means which the Board would employ to this end, the adjustment of labor controversies, the kind of ships and the number of ships to be acquired, the financial plans and the matters of mere organization, could be worked out under the blanket authority given.

Personnel of the Shipping Board

This Board should be composed of five men. The Secretary of the Navy should be an ex-officio member, by reason of his direct interest in a naval auxiliary and a naval reserve. The Secretary of Commerce, by reason of his direct interest in our foreign trade, should likewise be an ex-officio member. The three remaining members should be known as Commissioners, and should be shipping experts. They should be appointed by the President, by and with the consent of the Senate. One of the Commissioners should be designated by the President as the Chairman of the Board, and a second should be designated as the Vice-Chairman. No Commissioner should be actively engaged in any other business during his service on this Board.

The Shipping Board, as proposed, should be given authority to construct, in American shipyards, if possible, or elsewhere, if necessary, or even to purchase in the open market, a fleet of merchant vessels. These ships should be of such type and tonnage as will make them suitable for naval auxiliaries or army transports. This is the primary consideration. These vessels would, naturally, be avaliable for the merchant trade, but at all events should be so constructed and equipped as to make them of immediate use to our naval and military establishments.

Powers of the Shipping Board

Once the vessels have been acquired, either by construction or by purchase, the Shipping Board should be empowered to charter, lease or sell them to such corporations or individuals as will guarantee to use them for the transportation of commerce between the United States and foreign countries, and authority should reside in the Board to operate steamship lines, if such a condition should arise as to make it absolutely necessary. If, however, the ships are chartered, leased or sold to private parties at a low rate of interest, say four percent or less, it is reasonably certain that the emergency power just indicated will never have to be resorted to. This question of interest rates is one of great importance. While the war in Europe is in progress, and perhaps for years after it is over, money for marine investments abroad will necessarily be high. In our movement to organize a merchant fleet we should, therefore, use the credit of the government to the very best advantage.

In turning over government-owned vessels to private interests, a reservation should be made to the effect that no steamship line organized by this means should enter into competition with any existing American company supplying a satisfactory service at reasonable rates. It would be bad policy to interfere in any degree with such service or with any satisfactory service that may hereafter be provided by private American interests. It should not be the purpose of the Shipping Board to drive American enterprise off the seas. Its purpose should be to supplement, not duplicate, the efforts which our citizens may already be directing toward the extension of ocean facilities.

In order to provide a merchant fleet of sufficient proportions to meet our pressing commercial as well as our military needs, the Shipping Board should have at its disposal not less than $50,000,000 (£10,250,000). With this sum from forty to fifty ships, with an aggregate tonnage of approximately 500,000 gross tons, may be acquired. No fewer vessels will meet our present demands. Twice that number could be used to advantage in our trade campaign, and our naval authorities have urged the acquisition of at least this amount of tonnage if our fighting ships are to be even partially supported. The money could be raised without burdening the people with one dollar's direct taxation, by the sale of Panama Canal bonds, already authorized, and now in the Treasury unissued.

Inasmuch as the creation of a Shipping Board and the acquisition of a merchant fleet are predicated upon their value to our army and navy, the vessels in question should be available at any time for military purposes, and Congress should provide the power to take over temporarily or absolutely any or all ships for use as transports or naval auxiliaries at any time they might be needed. A fair rental, based upon the actual value of the vessels requisitioned, should be fixed for the protection of the operating companies and of those who may have invested in them.

Coastwise Shipping Should be Unmolested

Special provision should be made whereby the Shipping Board shall lend all possible assistance to the trade between the Atlantic and Pacific Coasts via the Panama Canal. It is doubtful if all the vessels which the Board may acquire should be permitted to engage in coastwise shipping. A vessel, for instance, that may be purchased abroad at a cheaper price than a vessel of the same type built in the United States, should not be permitted to compete with the domestic ship in the coastwise trade. It would, perhaps, be well to draw the line so as to admit to the coasting business only vessels built in American shipyards, either by the Board itself or by others who have sold or leased ships to the Board.

The President should be authorized to deliver to the Shipping Board any auxiliary vessel now belonging to the army or navy or controlled by the Panama Railroad, if, in his judgment, such vessels are not needed by either of these departments of the government. These ships, upon delivery to the Board, should become immediately available for commercial purposes and should be leased or sold to any interest that would guarantee to operate them on American trade routes. It is well known that the Navy Department now has a number of colliers, for instance, which it might conveniently convert into trade carriers, and to that extent furnish relief to our trade interests. There is no law, however, permitting the Secretary of the Navy or the President to utilize these ships for any other than naval purposes. These colliers, of course, would not be beyond the call of the navy in time of stress. They would have the same status as any other auxiliaries which the Shipping Board might have leased or otherwise disposed of, and could be recalled any time they were needed.

In order to carry out the purposes for which a Shipping Board may be created, that body should have authority to form a corporation, with the right to build, purchase and operate merchant ships to be used in extending the commerce of the country. The Board should have the power to subscribe in the name of the government to the stock of the corporation which it has formed, but should not subscribe to less than a majority of the shares, in order to maintain control of the corporation's affairs.

With the approval of the President, however, the Board should be permitted to sell the government's stock whenever private interests show a willingness to buy it, provided it can be disposed of on terms that are manifestly in the public interest.

Under such a provision as this the government would be engaged in the shipping business only so long as private enterprise held off. If at any time such interests wished to take over the corporation formed by the Shipping Board, they would have the privilege of making an offer to the Board for the government's holdings, and, if the President agreed, these holdings could be disposed of. Even then, however, the vessels owned and operated by the corporation should be available for military or naval emergencies. It would be wise to give railroads the right to buy or lease vessels controlled by the Shipping Board, provided such ships were used in extending the lines of the land carriers under conditions that would extend domestic and foreign trade without stifling competition.

Regulation of Domestic Enterprises

If a Shipping Board is to attain a state of highest usefulness, it must have the power to regulate the operation of all domestic enterprises engaged in shipping between American ports and between this country and foreign ports. This power of supervision should extend to all trade practices, to the determination of transportation routes, and to joint railroad and steamship movements of freight. The Board should even be given a degree of rate-making power. It should have authority, for instance, to prescribe maximum charges to be collected by all domestic corporations engaged in the shipping, and in certain instances should be allowed to fix preferential rates on export shipments when these may be necessary in order to promote trade expansion. It is, however, questionable whether the power to fix minimum rates should be given to the Board. The steamship business is often subjected to such conditions as make it necessary to reduce rates without notice. This would be impossible if the Board had arbitrarily fixed minimum as well as maximum rates.

In giving power to the Shipping Board to fix joint railroad and steamship rates, the authority of the Interstate Commerce Commission over the railroads should not be infringed upon. On the contrary, the latter body should be authorized to confer with the Shipping Commissioners to determine the reasonable proportions of a joint rate. Whatever these two bodies agreed upon should be enforced against the land and water carrier alike.

Revision of Navigation Laws

Another duty of importance should be assigned to the Shipping Board. It should have the power to inquire into all navigation laws of the United States now in effect, and should then determine what laws are unnecessary, oppressive or unduly burdensome either upon our shipping interests, our marine labor or our shipbuilding industry. At the same time the President should be given authority to suspend, upon the recommendation of the Shipping Board, any law or any part of a law which the Executive and the Commissioners may decide is against the best interests of the country. This suspension should be by Executive proclamation, and should remain in effect until Congress has had an opportunity to repeal the law or laws in question. Such a step as this would meet every existing demand for necessary changes in our navigation laws and would put the responsibility for such action upon the shoulders of the commission of experts, representative of all interests involved.

A feeling will no doubt prevail among those who may study the plan as so far outlined, that such a program deals only with domestic corporations or interests engaged in shipping and that the foreigner trading at our ports escapes all the regulations and supervision that it is now proposed to impose upon our domestic enterprises. And if the plan ended here this point would be well made. The plan, however, extends further; and though recognizing the fact that the Government of the United States has no jurisdiction over foreign corporations as such, it includes a license provision which has the same effect as jurisdiction.

Advantages of the License System

For instance, the law creating a Shipping Board should provide that every corporation, firm or individual desiring to trade in American ports must have a license from the United States, to be issued by the Shipping Board, giving vessels the right to enter and leave the ports of this country. Advantages of such a license system are obvious to any one who stops to consider the question. If we provide that a vessel must have a license or permit in order to touch at our ports, we can at the same time fix the conditions under which we will grant the permit. We can enforce our freight-rate regulations, compel the use of certain safety-at-sea equipment, bar unfair practices in competition, and exact obedience to our laws. All this may be accomplished by the simple expedient of giving the Board power to revoke the license of an offending steamship company. Such authority as contemplated is sweeping, yet it is absolutely necessary if we are ever to have even a semblance of control over alien ships that trade at our ports.

The Shipping Board and the merchant fleet which it is proposed to create give us our long-hoped-for opportunity to found a naval reserve. It has already been shown how the merchantmen may become auxiliaries for both the army and navy, and how this may be done without increasing our defense budget. I now propose to show how a reserve for the navy may be established with a comparatively small expenditure of money.

Naval Reservists

The officers and crew of every merchant vessel controlled by the Shipping Board should be given the privilege of volunteering as reservists, and such of these men as qualify, after being examined, might be enrolled as members of the Naval Reserve in various ranks and ratings corresponding to those in the navy itself. All such volunteers must be citizens of the United States, and the regulations for the reserve should be approved by the Secretary of the Navy. The examination for admission to the reserve of officers and men should be held by naval officers designated by the Secretary for that purpose. All reservists received into the corps by this means should receive an allowance from the government in addition to their pay as merchant sailors. This allowance should not exceed $5 (1/0/10) a month for enlisted men, $10 (2/1/8) a month for petty officers, $12 (2/10/0) a month for warrant officers and $15 (3/2/6) a month for commissioned officers.

It cannot be doubted that such an investment in a naval reserve would be mutually beneficial to the navy and to the merchant marine. In the first instance, it would provide a body of from 10,000 to 15,000 trained reservists for the naval establishment, a military asset of which we are badly in need. It would take but little additional training to convert a merchant sailor into a naval sailor, a merchant officer into a competent naval officer. From another point of view, a naval reserve would invite a far more desirable class of young men to the sea than ever before. Instead

of our country boys going to the already overcrowded cities, they would have open to them fine careers in the merchant marine, and be able to hold positions yielding dual pay. From any point of view the naval reserve in our merchant fleet will be worth every dollar it may cost our government and a great deal more.

A report recently made to Secretary McAdoo by Captain-Commandant E. P. Bertholf of the United States Coast Guard shows that a naval reserve of 10,000 men can be maintained by this plan at an annual cost of approximately $600,000 (£123,000), or about as much as the annual cost of keeping in service a single battleship of modern type. What an insignificant sum to pay for this essential feature of naval preparedness!

The Shipping Commissioners

A Shipping Board, however ideally conceived, cannot rise to its full responsibilities unless its members are men of the highest type. They must be of the same relative calibre as those who compose the Federal Reserve Board. They must command the implicit confidence of the country and must have no other interest than that of our merchant marine, our foreign trade expansion and our military preparedness. Such a body as defined in the foregoing will have many important issues to meet. The labor problem will be a difficult one. Our business men will raise question after question, and our shipowners themselves will present perplexing problems for solution. It would seem necessary, therefore, to name as Commissioners men who would in one way or another be familiar with these vital interests. Then, by common counsel and an exchange of ideas, they would be able to administer the affairs over which they had jurisdiction for the general good of all concerned.

It is not impossible that in the course of a few years Congress, after experimenting intelligently with a Shipping Commission, will go a little further and create a Department of Marine. All leading maritime nations have such departments, presided over by a Cabinet Officer or Minister. All of them recognize the inherent value of shipping as a national asset, and give it equal representation with other interests in their systems of government. Before such a consummation is possible, however, the present idea must be tried out and must justify itself by actual service to the country.

Adjustment of Competitive Conditions

It may be fairly expected that with a Shipping Board in authority over our merchant marine, we will be in better position to deal with maritime interests of other nations in harmonizing differences and in adjusting competitive conditions. Conferences should be held to discuss questions affecting all nations alike. Conciliatory proposals would be forthcoming when sharp issues were raised, and co-operation would be possible once European nations found that we have a responsible body with whom they could negotiate and a merchant fleet with which they must reckon. All this will be infinitely easier as a result of the handicaps under which European shipping will labor as a result of the present war.

A Shipping Board, such as here suggested, should make reports annually to Congress embodying recommendations for the further extension of our trade facilities. One of its first duties in this connection should be the preparation of a comprehensive plan for changes in the Ocean Mail Act of 1891, in order to secure additional fast mail, parcel post and passenger lines from our shores to foreign ports. The Board could serve Congress most efficiently in an advisory capacity, and should have the widest latitude not only in the enforcement of existing laws and regulations, but in urging upon Congress the necessity for others.

This program represents a new and constructive policy with respect to our merchant marine. We all know that the policies of the past have failed, that the hopes of our people have been disappointed, and that our foreign commerce has been sacrificed. A new course must be pursued. New remedies must be applied, otherwise we shall stand still as a maritime power while the remainder of the world moves away from us.

A great countryman of ours has said that "the hardest thing to get done is that which everybody admits ought to be done." It is perhaps this fact which has kept us from doing our duty in providing a merchant marine. But, in the name of all that is wise and prudent and patriotic, let us no longer postpone the work. Let us, as good citizens and loyal Americans realize the responsibilities of the future and prepare to meet them!

Shipping Bill Submitted to Congress by New York Chamber of Commerce

A shipping bill for encouraging the building and operating of merchant steamers in foreign trade under the American flag, compiled by a committee of twenty-five members of the Chamber of Commerce of the State of New York, was introduced in Congress on February 19. The bill is offered as a practical substitute for the pending Administration shipping bill, and involves four special features: First, the creation of a Federal shipping board; second, the reduction by the Postmaster-General at his discretion of the speed limits for mail ships in foreign trades; third, the payment by the Government to American shipbuilders of sums sufficient to make up the difference in cost of building American and foreign ships; and fourth, the payments by the Government to American shipowners of sums sufficient to make up the difference in cost of operating American and foreign ships.

The Merchant Shipping Board proposed consists of seven members, including the Secretary of the Navy and the Secretary of Commerce and five members appointed by the President, for terms of seven years at annual salaries of $10,000 (£2,050). According to the bill compensation for ocean mail service shall be made according to the scale provided in the ocean mail act of March 3, 1891, with the proviso, however, that at the discretion of the Postmaster-General vessels of 15 knots speed shall be entitled to receive the maximum rate, vessels of 12 knots speed the second largest rate and vessels of 10 knots speed the third largest rate.

The equalization of building and operating costs of American vessels as compared with foreign vessels would be in the hands of the Merchant Shipping Board. One of its duties would be to gather and compile information concerning the differences between the cost of building and operating merchant vessels in the United States and in foreign countries. It would also be its duty to examine the navigation laws of the United States and make such recommendations to Congress as it may deem proper for the amendment, improvement and revision of such laws for the development of the American merchant marine. The Shipping Board would also be empowered to make regulations concerning the construction, equipment, structural strength and load line of vessels and their inspection and upkeep. It would also be the duty of the Shipping Board to investigate the legal status of mortgage loans on vessel property with a view to improving the security of such loans and encouraging investment in American shipping.

American Shipyards and Marine Repair Plants

Present Shipbuilding Facilities in the United States—Merchant Tonnage Under Construction—Recent Improvements

A THOROUGH canvass of over 50 shipyards in the United States has shown that practically every shipbuilding plant in the country which is equipped for building steel vessels is filled with work for at least two years to come at prices far above normal. Several new yards have been opened and the establishment of others is contemplated. In all, about 300 merchant vessels aggregating about 1,150,000 tons, are now under construction, while, in addition, about 70 government vessels, aggregating at least 150,000 tons displacement, are also being built in private yards, bringing the total volume of ship construction now in hand in the private yards up to about 370 vessels of 1,300,000 tons.

While the returns (as given in the accompanying table) upon which the above estimate is based are necessarily incomplete, they nevertheless measure with sufficient accuracy the present capacity of production of the principal shipyards in the United States. At no other period in the recent history of American shipbuilding have the facilities of the shipyards in the United States been so fully utilized for the construction of merchant vessels, and the result will be a material increase in the American merchant marine—although almost wholly for domestic use.

The Shipyards

Of the merchant vessels now building, 98 are freight steamships, 68 are oil tank steamers and 7 are passenger and freight steamships. Thirty of the vessels building are of 10,000 tons or over, 61 are of from 5,000 to 10,000 tons, and 35 are of from 3,000 to 5,000 tons. It is noteworthy that of the 30 vessels of 10,000 tons or over under construction, 19 are oil tankers, showing the unusual growth of the great oil-carrying fleets.

An insight into the facilities available in the United States for building ships can be gained from the descriptive articles in the following pages, which show briefly the extent of the equipment provided in the individual yards and the nature of the work turned out.

NUMBER AND APPROXIMATE TONNAGE OF VESSELS UNDER CONSTRUCTION IN PRIVATE YARDS FEBRUARY 18

Shipyard	Merchant Vessels		Government Vessels	
	No.	Gross Tons	No.	Displacement
American Bridge Company	22	10,533	..	....
American Car & Foundry Company	12	5,039	..	....
American Shipbuilding Company	20	81,300	..	....
Anderson Steamboat Company	4	....	1	360
Baltimore Dry Docks & Shipbuilding Company	7	24,500	1	750
Charles Barnes & Company	2	720	1	360
Clinton Shipbuilding & Repair Co.	2	560	..	....
Bath Iron Works	4	2,668	3	3,305
H. M. Bean	1	....	..	....
F. S. Bowker & Sons	2	1,134	..	....
A. C. Brown & Sons	3	....	..	....
Chester Shipbuilding Company	7	40,600	..	....
California Shipbuilding Company	..	....	6	....
Wm. Cramp & Sons Ship & Engine Building Company	12	75,200	4	4,360
G. G. Deering Company	1	1,900	..	....
Dubuque Boat & Boiler Works	2	85	..	....
J. F. Duthie & Company	1	....	..	....
Electric Boat Company	..	....	8	....
W. & A. Fletcher Company	1	....	..	....
Fore River Shipbuilding Corporation	9	80,000	20	....
Great Lakes Engineering Works	15	63,487	..	....
Harlan & Hollingsworth Corporation	13	85,000	..	....
Howard Ship Yards Company	7	4,600	..	....
Johnson & Lanteri	1	....	..	....
Johnston Brothers	..	....	2	800
Kelly-Spear Company	5	3,380	..	....
Lake Torpedo Boat Company	..	....	8	....
McKay Shipbuilding Company	1	550	..	....
Manitowoc Shipbuilding & Dry Dock Company	10	14,000	1	1,000
Maryland Steel Company	13	75,000	..	....
Mathis Shipbuilding Company	3	....	..	....
Mathews Shipbuilding Company	3	....	..	....
Merrill-Stevens Company	..	....	1	170
Moore & Scott Iron Works	3	9,000	..	....
Newport News Shipbuilding & Dry Dock Company	17	128,000	2	63,400
New York Shipbuilding Company	24	153,913	4	62,180
Percy & Small Company	1	898	..	....
Pusey & Jones	5	1,020	2	....
James Rees & Son Company	1	460	..	....
Sawyer Bros.	1	600	..	....
Seattle Construction & Dry Dock Co.	4	16,800	4	....
Skinner & Eddy Shipbuilding Co.	2	14,250	..	....
Spedden Shipbuilding Company	6	....	..	....
Staten Island Shipbuilding Company	6	1,683	..	....
Arthur D. Story	2	279	..	....
Tampa Foundry & Machine Company	1	2,000	..	....
The Texas Company	4	36,000	..	....
Toledo Shipbuilding Company	11	29,200	..	....
Townsend Marine Ry. & Cons. Co.	3	1,260	..	....
United Engineering Works	3	....	..	....
Union Iron Works	19	179,078	..	....

Additions and Improvements

Should future conditions warrant the large expenditures that would necessarily be required for materially increasing the present building facilities in the existing yards, the demand could be met without difficulty in many cases, as nearly all of the large yards when originally laid out were planned with a view to future expansion. Not infrequently the property owned by the shipbuilding company is only partly utilized at the present time for shipbuilding purposes, and with the water front available immediate expansion of the building facilities could be readily accomplished to meet any demands that might result from conditions promising a reasonably permanent growth of American shipping.

In practically all of the shipyards, however, the present unprecedented demand for merchant tonnage, although resulting from abnormal conditions, has led to a general expansion of facilities by the addition of new building ways, the erection of new shops and the installation of new machinery and other equipment. A striking illustration of this is the virtual reconstruction of the yards that in recent years have become subsidiaries of the Bethlehem Steel Corporation. In this group are the Fore River Shipbuilding Corporation, the Harlan & Hollingsworth Corporation and the Union Iron Works, where in every case the improvements have been on a scale that indicates a confident belief in the permanent growth of the American shipbuilding industry.

Conditions in the Repair Yards

Owing to the unusual conditions during the past eighteen months, when the scarcity of tonnage has brought into service every available vessel to take advantage of the profitable freight rates offered, the facilities for overhauling and repairing vessels of every type have been taxed to the utmost. As a result, new equipment has been called for and comprehensive plans for increasing the capacity of existing repair yards have been put into effect.



THE FORE RIVER SHIPYARD

Extensive Additions and Improvements Rapidly Increasing Capacity of Fore River Shipyard at Quincy, Mass.—New Shops and Building Slips

THE Fore River Shipbuilding Corporation is a subsidiary of the Bethlehem Steel Corporation and was established in its present location in 1900. Its predecessor was a smaller yard for the building of yachts and machinery located at Weymouth Landing about two miles from the present yard. As a result of the large amount of government work for the navy in 1900 because of the Spanish-American War the company at Weymouth Landing had received contracts for the torpedo boat destroyers *Lawrence* and *MacDonough* and for the sheathed protected cruiser *Des Moines,* and were low bidders for the battleships *New Jersey* and *Rhode Island.* The large amount of business necessitated the establishment of the larger and more modern plant which was established at Quincy Point on the Weymouth Fore River in the year 1900, in a location that had been celebrated for two centuries as a shipbuilding center for sailing vessels, one of the oldest shipyards in the United States having been located not far from the present plant.

The shipyard proper embraces an area of about 40 acres, and there is in addition a large amount of outlying property. It is about five miles from Boston Light, and in fact is nearer the open sea than the principal docks of the City of Boston. It is located on a completely land-locked harbor where it is safe from damage from the violent storms of the North Atlantic and well protected by the fortifications of Boston Harbor in time of war. It has a channel depth to the open sea at the present time of 30 feet of water at high tide. The mean draft of water at low tide at the company's wharves is 28 feet.

The shipyard is connected by its own railway line, 1⅝ miles in length, to the New York, New Haven & Hartford Railroad Company, Plymouth Division, at East Braintree. There are about 3½ miles of railroad line within the company's plant, so that material received can be delivered to any part of the plant and handled by overhead traveling cranes or industrial locomotive cranes to any point desired.

The shipyard has nine building slips, lettered from *A* to *J,* and all of these are now covered by overhead cranes. An addition slip, lettered *K,* is now under construction for handling merchant vessels any size up to 600 feet and fitted with two overhead traveling cranes capable of handling a maximum combined load at one time of 30 tons. The slips *A, B, C* and *D* have 5-ton overhead traveling cranes; slips *E, F* and *G* have two 10-ton traveling cranes, and slips *H* and *J,* which are under what is known as the overhead ship structure which was erected in 1901, are each fitted with two 5-ton cranes.

The company has under construction at the present time a ship fitters' shop for the handling, fabrication, assembling and riveting of structural steel which is worked into the ships. This shop is 775 feet long by 185 feet wide and when completed will be the best shop of its type

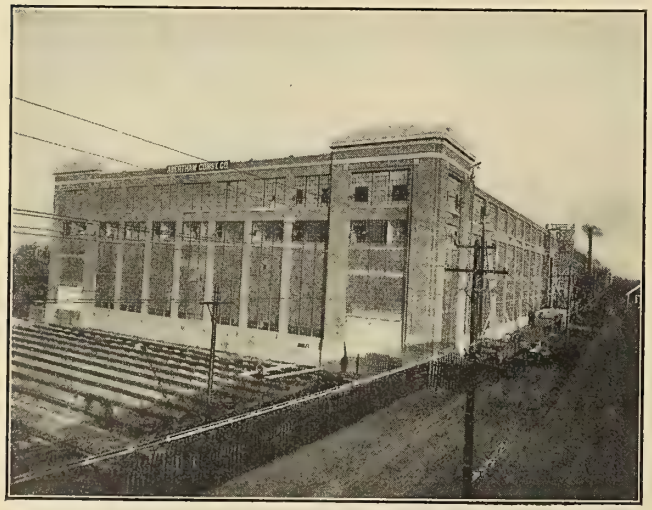


Fig. 2.—New Ship Shed



Fig. 3.—New Plate and Shape Storage Yard



Fig. 4.—Machine Shop



Fig. 6.—Main Office Building

in the United States. It is built of steel, brick and concrete and is practically fire proof in its construction, with the maximum amount of steel sash and natural lighting. It is divided into two bays about 90 feet span each, with two overhead traveling cranes in each bay, and underneath them on each side are a suitable number of wall cranes for serving the machines. There are, in addition, a large number of jib cranes for serving individual machines and each crane is fitted with an electric hoist. The building is equipped with a large amount of new machinery, new furnaces and other equipment.

The layout of the plate yard for stowing of structural material and of the narrow-gage railways for handling it at the end of the shop is shown in Fig. 3. The structural material is received in the yard on the cars and from them is handled by three gantry cranes. Two electric storage-battery trucks run into a bin at the end of the shop from which the material is lifted by overhead cranes to suitable locations for working. In addition to the crane facilities at the end of the shop, there are other storage-battery trucks for handling material lengthwise in the shop and at the far end across the slipways each of the existing slipways is to be extended about 300 feet, so that all material delivered through a large door in the side of the shop at the far end can be handled in a straight line out of the shop and delivered under any one of the slipways, where it can be handled directly to its place in the ship with the overhead traveling cranes.

The second floor of the new shop has a mold loft 600

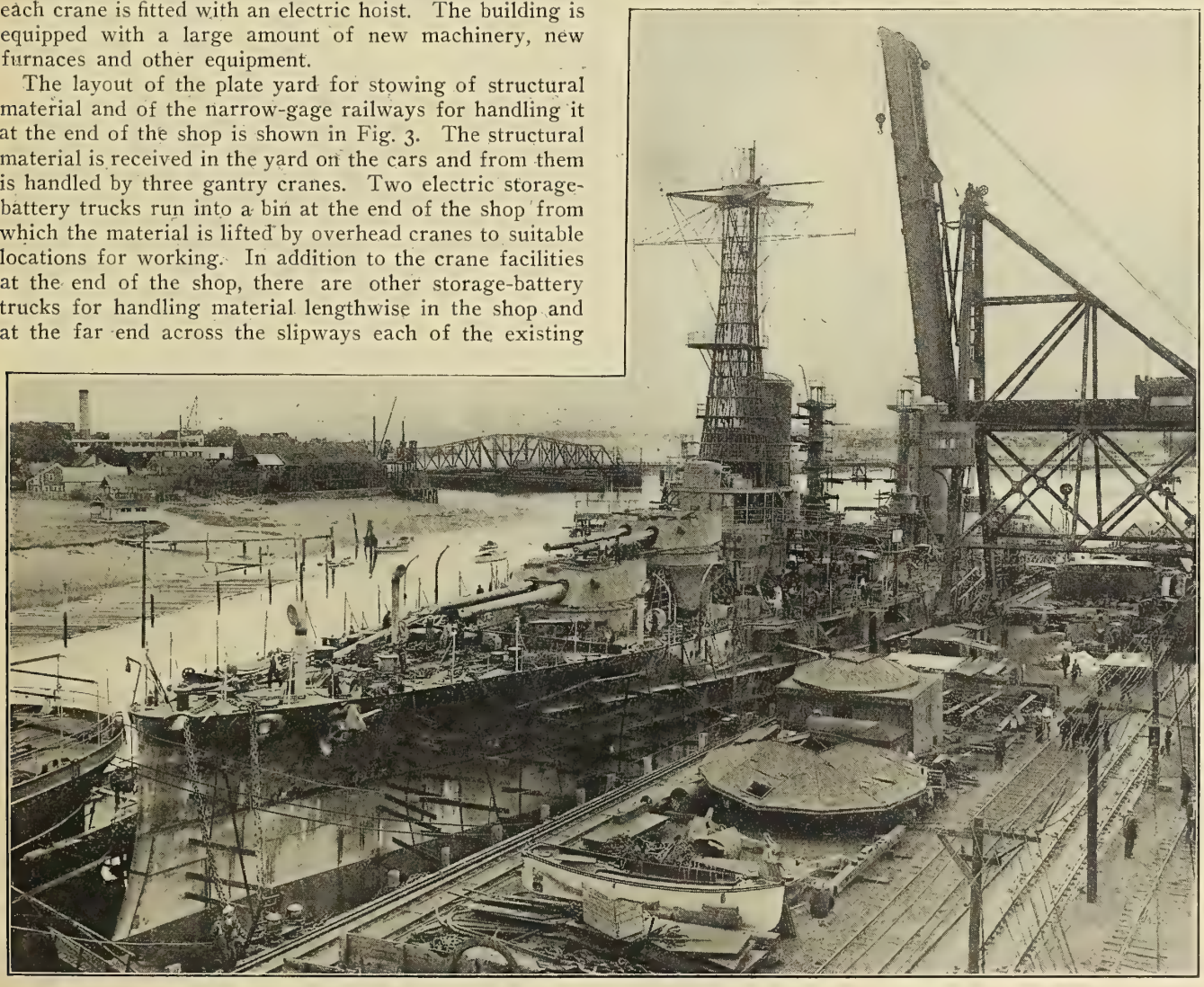


Fig. 5.—Fitting Out Berth, with Argentine Battleship *Rividavia* Under Construction

feet long by 100 feet wide, the largest of its type known. It has, in addition, a sheet metal shop, which is to be transferred from its present location to these new and better equipped quarters. Every tool and appliance fitted in the shop is being installed with a careful regard not only to its efficient operation but to the safety of the workmen. Ample and thoroughly sanitary washrooms and toilet appliances are being fitted for every man employed in the shop. A large number of offices for yard inspectors on the general superintendent's staff are being constructed on a mezzanine floor at the height of the first floor trusses.

berthed, the material is handled on board the vessels by means of industrial cranes.

For the distribution of material around the yard the company has in continual operation two locomotives and 24 flat cars, four industrial cranes which can lift 15 tons weight; and for the handling of miscellaneous small material there are two auto trucks, one gasoline (petrol) of 3½ tons capacity, and the other, electric, of two tons capacity.

In addition to the structural iron work department, the yard is equipped with all other machinery required for the



Fig. 7.—Interior of Machine Shop

Coal and some shipments of lumber are received by water, but all other shipments of whatever character are received by rail.

For ships completing in the water there is dock space, as shown in Fig. 5, where there is a minimum depth of 28 feet alongside the long dock, and which is served by a traveling gantry crane with a maximum lifting capacity of about 100 tons, and which has actually placed turrets weighing 92 tons in position at the center line of a battleship.

There is now under construction, 350 feet across from the present long dock, a new sea wall, 500 feet in length, for the mooring of a battleship or large ships of any type. It is expected later to extend this wall an additional 500 feet, to furnish better docking facilities for larger vessels.

In another basin or wet dock where smaller boats are

building of high grade merchant or government vessels as well as any grade of cargo boats.

The machine shop shown in Figs. 7 and 8 is 520 feet long and 118 feet wide, fitted with overhead cranes running the entire length of the shop. The extension at the far end of the shop, which is steel, brick and concrete construction, was built last year for the installation of some large surfacing plates inside of the shop. This new end construction represents the type of construction that will replace the entire wooden building within two or three years. Some of the special machines in this shop are as follows:

Boring mill for turret track with a swing of 32 feet; 120-inch planer; large lathe for turning shafting, capable of boring a shaft 50 feet long; a specially constructed lathe for turning turbine rotors up to 12 feet in diameter, and

a machine for the planing of propellers, shown in Fig. 9.

There is probably no shipyard machine shop in the country equipped with an equal amount of up-to-date machinery. At times an output in excess of 1,000,000 pounds machined material per month has been reached. All of the heavy work is done on the main floor, which is served by the overhead cranes mentioned before, and there are two galleries, running the entire length of the shop, on which the lighter grades of work are done; one gallery of which is devoted entirely to brass work. This shop has employed at times as many as 750 men working in two and three shifts.

The pipe shop is equipped with all the necessary tools for the cutting, threading, bending and working of iron, steel, brass and copper piping. There is also a sheet metal shop for all kinds of light sheet metal work, special brass work and wire work.

The shipwrights, joiner and patternmakers' shop has up-to-date equipment of machinery and ample space for handling all kinds of wood work. Plans are now being prepared for the construction of a new pattern, joiner and shipwright shop, which, when completed, will permit the removal of the old wooden building which marks the site of the future power house.

The brass foundry, where all the brass castings for the plant are made, had an output for the month of January, 1915, of 339,000 pounds of good castings; an output which it is believed has never been equaled in a foundry of this size anywhere.

The blacksmith shop is up to date in every particular; and there is an electric workshop and a rigging loft; also a galvanizing plant with a capacity in excess of 250,000

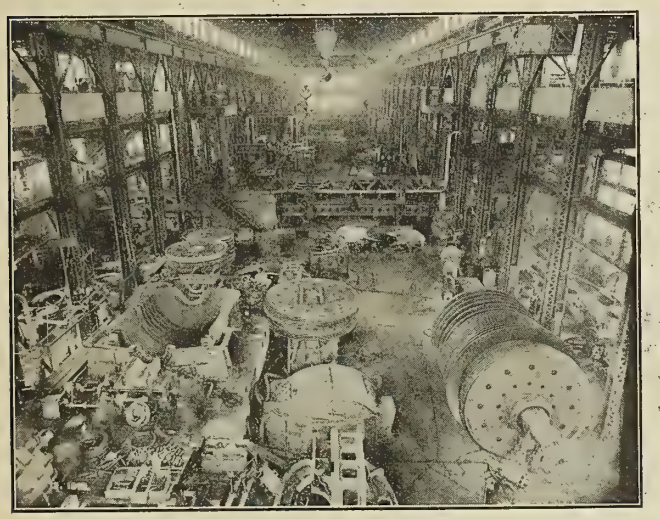


Fig. 8.—Curtis Turbines Under Construction in Machine Shop

pounds per month; a boiler shop for the building of water-tube boilers, and small buildings required for the construction of various auxiliaries used in shipbuilding.

A special feature of the plant is a new storehouse, of brick and steel and concrete construction, consisting of a basement and three complete floors, and a mezzanine floor. The main floor is fitted with an overhead crane for the handling of heavy material and an elevator is provided for serving the other floors. This building was recently constructed and is intended to handle in the most efficient manner all raw material, also the semi-finished and finished material used in the construction of ships, except plates and shapes and the larger castings. The interior shelving, bins, etc., are entirely of metal and have been laid out with great care, due to the efficient handling of the various types of material. It is believed that the question of the efficient storage under cover of all materials, which go to make up a complete ship, has received, for the first time, the attention which this important service demands.

During the fourteen years of its existence the corporation has built and completed or has under construction 165 vessels, including five battleships, the *Rhode Island, New Jersey, Vermont, North Dakota,* for the United States Government, and the *Rividavia* for the Argentine Government; and at the present has under construction the battleship *Nevada* for the United States Navy. It has built a large number of submarines for the United States Navy, and several for foreign governments. It has built Curtis turbines for the Japanese Navy and for the Italian Navy.

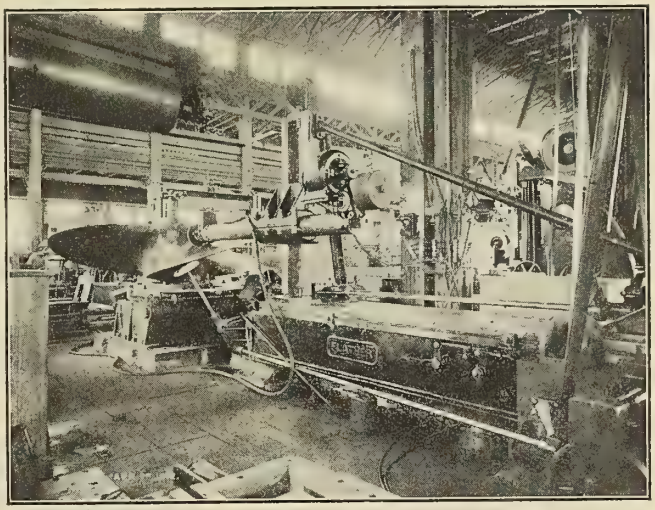


Fig. 9.—Propeller Planing Machine

Three of the United States battleships built at this yard made the trip around the world in 1907 and 1908. The corporation also performs miscellaneous work in addition to its shipyard work proper.

The corporation is at present employing about 4,500 men with a weekly payroll averaging $65,000 (£13,300).

The installation of a power plant with gas-driven machinery is contemplated, the gas to be produced from a suitable plant in the company's works. This plant will be of ample capacity for furnishing all of the pneumatic and electric power required in the company's business. There will be in addition an auxiliary steam plant for heating and other purposes.

Standard Shipbuilding Corporation

The Standard Shipbuilding Corporation, New York, which has taken over the shipyard property on Shooter's Island, Borough of Richmond, New York, is planning to build stock cargo steamships of about 7,400 tons of 23 feet draft, with a speed of 10½ knots with coal as fuel and 11½ knots with oil as fuel. The propelling machinery will consist of Scotch boilers and triple expansion engines. The company has purchased sufficient steel plates and shapes to build three of these vessels, and will proceed with their construction as rapidly as the necessary material is delivered. It is expected that the first of these vessels will be completed about the last of this year and one about every two months thereafter. The company's plant, which has remained idle for a number of years, will also provide facilities for dry docking and ship repairs.

Annual Meeting of Institution of Naval Architects.—The annual meeting of the Institution of Naval Architects will be held in the hall of the Royal Society of Arts, John street, Adelphi, London, W. C., on April 12 and 13.

Bath's Leading Shipyard

New Tools and Other Equipment Added to the Plant of the Bath Iron Works, Ltd.

The largest shipyard in Bath, Me., and until the present time the only shipyard in this "famous city of ships" to engage in the construction of steel vessels, is the Bath Iron Works, Limited, a plant which has a well-deserved reputation for its success in the construction of fast steam vessels. The company now has under construction in its splendidly equipped plant three torpedo-boat destroyers for the United States Navy, two of which are about ready for launching, a 225-foot destroyer-type of turbine-driven yacht for Mr. P. W. Rouss of New York, another steam yacht of similar design, 240 feet long, for Mr. John Willys, manufacturer of the Overland automobile, and two large car floats for service in New York Harbor. While this company has specialized in the construction of high speed naval vessels its success in the building of high speed merchant and pleasure boats has been no less marked.

The plant is up to date in every particular. The shops are nearly all of brick, steel or concrete construction, well lighted and ventilated. The various departments include a machine shop and boiler shop, where Parsons turbines and Normand express boilers are built, a copper and tin shop, a pipe shop, a blacksmith shop, a carpenter and joiner shop and a foundry; so that when a ship is contracted for by the Bath Iron Works the entire ship can be built in its plant. Nearly 1,000 men are employed in the plant, and the fact that labor troubles are practically unknown goes a long way to prove that the cooperation of officials and employees has made this successful plant what it is to-day.

During the last year the plant has greatly increased its efficiency by the installation of many new tools, etc., such as a new 26-foot plate rolls and a 5-inch horizontal boring mill and vertical boring mill in the machine shop, so as to meet the exacting requirements of high speed work, and a 5-ton overhead crane which facilitates the handling of all large plates in the plate yard.

The company was one of the first to take out a license for the construction of the Parsons marine steam turbine and during the past nine years has built and is building 19 vessels equipped with these turbines, of a total horsepower of 240,900, or a larger amount built and building than by any other of the American licensees.

They are also American licensees for the building of Normand express watertube boilers, of which they have

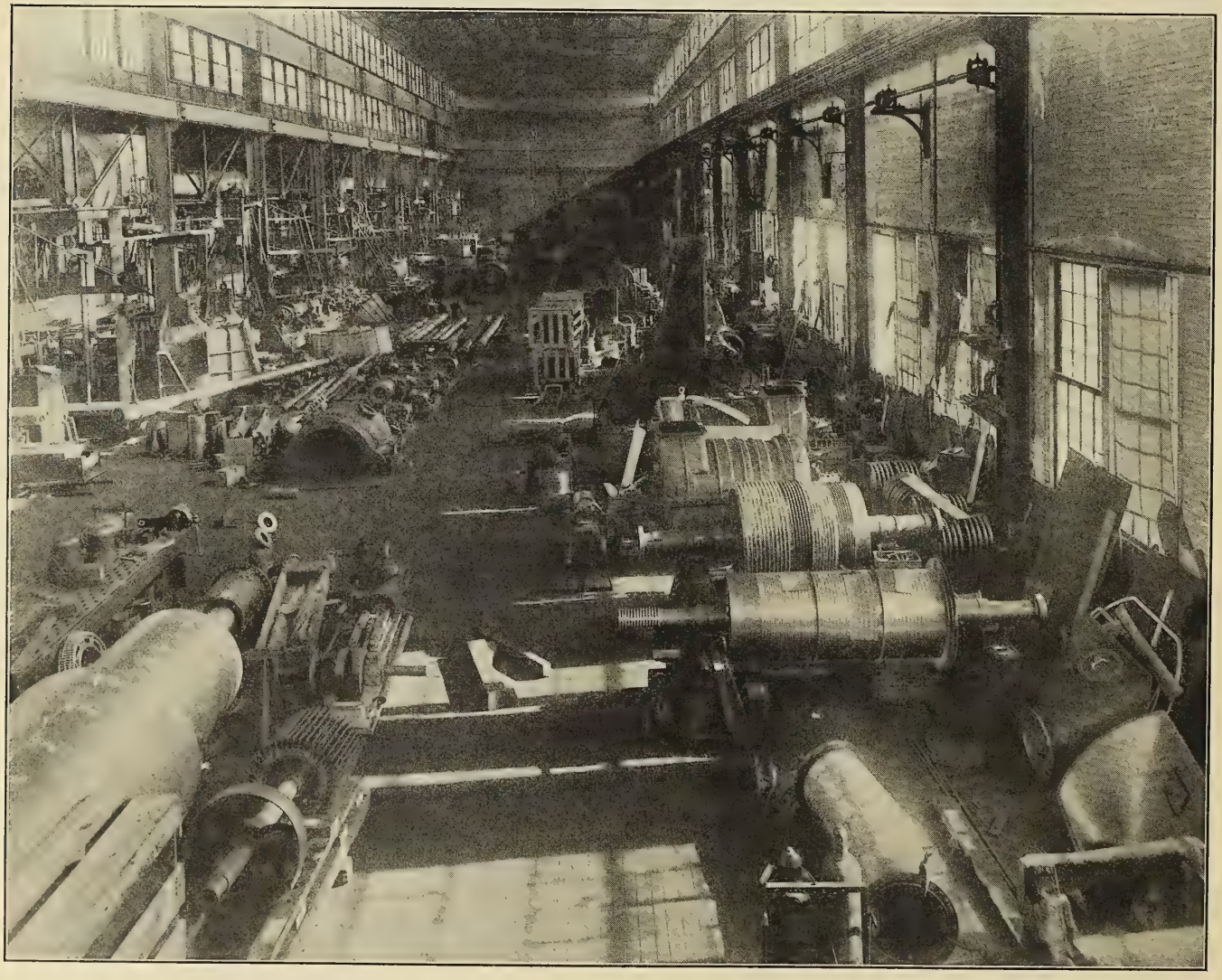


Fig. 1.—Machine Shop of the Bath Iron Works, Showing Parsons Turbines Under Construction

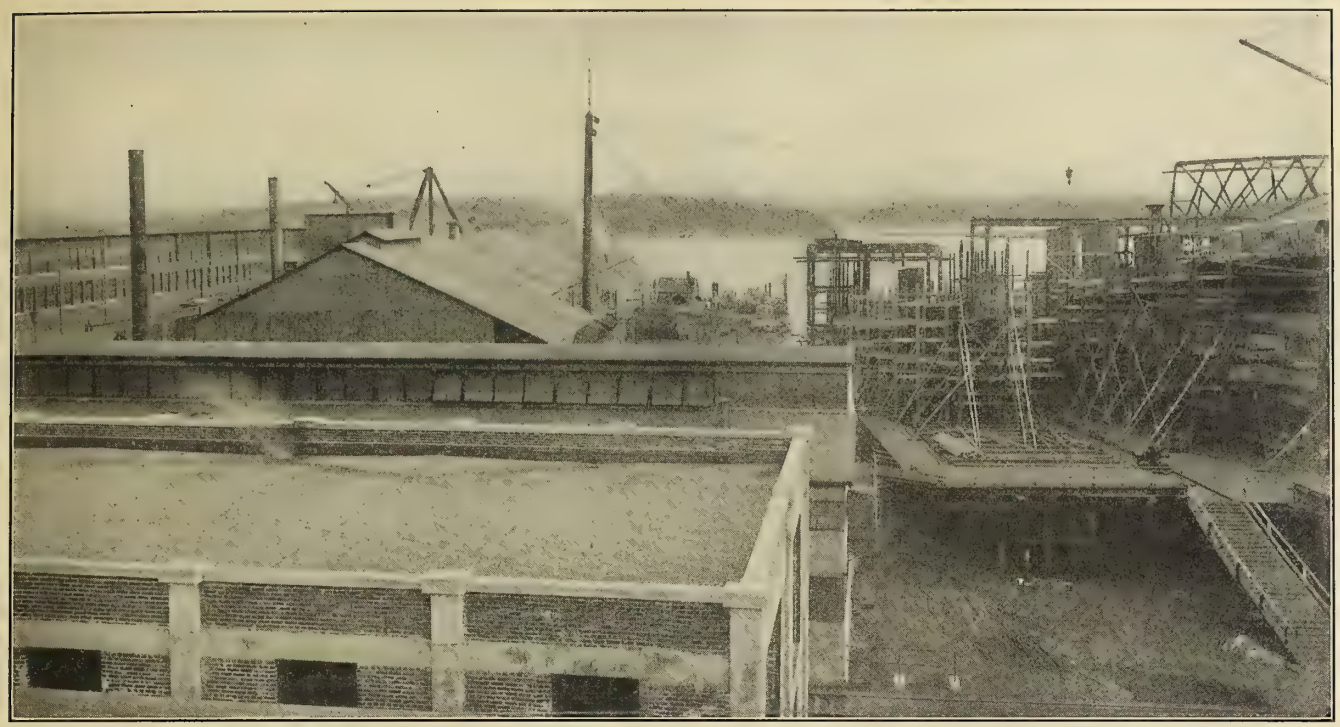


Fig. 2.—Partial View of Building Slips and Shops of the Bath Iron Works

constructed 85, having a total heating surface of 364,203 square feet, and with which all the high-speed vessels built by them have been equipped.

The last nine destroyers built by the Bath Iron Works are equipped with oil-burning apparatus, and the three destroyers now being built by them are also to be oil burners and to be equipped with Normand boilers and Parsons turbines.

Through their experience in building work of the character of that on which they have been engaged, the company has accumulated a very valuable mass of data and thorough experience.

For the installation of machinery on board vessels the company has a steel, electrically operated wharf crane of 75 tons capacity. A large repair business is done. They also build boilers of all kinds, tanks, pulp mill digesters and machinery, penstocks, stand pipes, and general boiler, machine, smith, copper and sheet metal, piping, plumbing and brass foundry work. The plant is compactly laid out on a plot about 700 feet square.

Shipbuilding on the Kennebec

Wooden Shipbuilding Active—New Steel Shipbuilding Plant for the Texas Company

That the year 1916 bids fair to be the banner year in shipbuilding on the Kennebec river is shown by the work now in progress in the shipyards of Bath and its vicinity. In the yard of Frank S. Bowker & Son, five miles down the Kennebec from Bath, the keel has been laid for a three-masted schooner of about 650 tons burden. The G. G. Deering Company will shortly deliver from its yard at the south end of the city a five-masted schooner of 1,800 tons gross, and as soon as the material arrives at the yard the keel of another schooner of the same size will be laid.

Only a stone's throw from the Deering plant in the yard of the Percy & Small Company, a four-masted schooner suitable for any trade (one of the most popular types of sailing vessels) is on the stocks. After the vessel is launched in March work on another vessel of the same type will be commenced immediately.

The Bath Iron Works, the next yard in line coming up the river, is extremely busy, having under construction three torpedo-boat destroyers, two large steam yachts and two steel car floats. A further description of this plant will be found elsewhere in this issue.

Further up the river the plant of Arthur Sewall & Company, builders of many of the finest and largest sailing vessels that have carried the American flag overseas, has been leased to the Texas Company of New York, which has a large crew at work putting the yard in shape to build four steel steamers of 9,000 tons each. The Texas Company expects to have two of these steamers on the stocks by June 1. After the first four steamers are completed it is likely that other vessels will be laid down, as the yard has been leased for a long term. The Texas Company intends to utilize local labor as much as possible, as some of the best ironworkers in the coast yards were formerly wooden shipbuilders on the Kennebec.

At the extreme north end of the city the Kelly-Spear Company is now completing two railroad terminal scows for New York owners and one coal barge.

In addition to the shipyards mentioned above, Bath is the home of the Hyde Windlass Company, manufacturers of windlasses, steam stearing engines and propellers. The efforts of this company, combined with those of the shipbuilders, have won for Bath the title of the "city of ships."

The Cramp Ship and Engine Building Plant

Burmeister & Wain Diesel Engines to be Built at the Cramp Yard—New Shops and Equipment

The famous Cramp shipyard, founded in Philadelphia eighty-six years ago by the late William Cramp, is not only the pioneer among the large shipyards now established in the United States, but has steadily maintained a foremost place in this important industry, both at home and abroad. At present the plant, which embraces the Cramp shipbuilding yard, the Kensington Shipyard Company, which is used for dry-dock work and repairs, the I. P. Morris Company, machinists and iron founders, and the Federal Steel Foundry Company, manufacturers of steel castings, occupies an area of sixty-five and one-half acres, with a water front of 2,058 feet. In all there are nine building slips, two of which were only recently added; a large dry dock; two smaller marine railway dry docks, and two fitting-out berths.

New Shops and Equipment

Extensive improvements are now under way, including the construction of a large new ship shed, two cranes for the wet dock, two new building slips with three new cranes, and a new office building. Sixteen vessels are now under construction in the yard, including four United States torpedo-boat destroyers, seven oil-tank steamships, two passenger and freight vessels, two freight steamers and a car ferry, furnishing employment for about five thousand men.

The William Cramp & Sons Ship & Engine Building Company has recently acquired from Messrs. Burmeister & Wain, of Copenhagen, Denmark, the rights to build the Burmeister & Wain Diesel marine engine in the United States.

Two of the building slips are 850 feet long and 110 feet wide, two are each 630 feet long, one being 110 feet wide and the other 83 feet wide; two are 600 feet long and 69 and 66 feet wide, respectively; two 400 feet long by 54 feet wide, and one 320 feet long by 35 feet wide. Four of the slips are served by overhead traveling cantilever cranes of 14 tons capacity; two are served by four 10-ton overhead electric traveling cranes; two are served by three 10-ton stationary electric cantilever revolving tower cranes, and one by stationary jib cranes.

Dry Docks

The large dry dock is 432 feet 11¾ inches long over all and 45 feet wide at the bottom and 111 feet wide at the top, while the entrance is 48 feet wide at the bottom and 69 feet wide at the top. The dry dock is fully equipped with a separate machine shop, pattern shop, ship shed, joiner shop, power house, wood finishing department, paint shop, boiler house, rigging department, pipe shop and storehouse. Of the two marine railways, one is of 3,000 tons capacity, 270 feet long over keel blocks and 48 feet 10 inches wide, while the other is of 1,000 tons capacity, 240 feet long by 35 feet wide.

The two fitting out berths, one of which is 990 feet long by 188 feet wide, and the other 450 feet long by 55 feet wide, are served by stationary electric cantilever tower cranes of 10 and 20 tons capacity, respectively. There is also a 100-ton floating derrick crane, the first, and for many years the largest, crane of its type in the United States. Electric power for distribution to the shops and yard tools is furnished by two power plants, one housed in a two-story building, 132 feet by 60 feet, and the other in a three-story building 72 feet by 60 feet.

The various shops in the yard are of unusual size and capacity. They include three machine shops, the first a two-story building 458 feet by 140 feet, the second a three-story building 142 feet by 333 feet, and the third, of U-shape, 320 feet by 250 feet by 230 feet by 66 feet. The iron foundry consists of two buildings 450 feet by 110 feet and 130 feet by 110 feet. The smith shop is 290 feet long by 100 feet wide; the joiner shop is a two-story building 190 feet by 80 feet; the electrical department is a two-story building 165 feet by 66 feet; the paint shop is a two-story building of L shape 210 feet by 95 feet by 32 feet; the ship shed is also a two-story building 540 feet long by 212 feet wide; the boiler shop is 330 feet long by 160 feet wide, and the pattern shop is 338 feet long by 60 feet wide. The old ship sheds are 440 feet by 150 feet and 150 feet by 60 feet, while the old paint shop is a two-story building, 194 feet by 50 feet. The plant also includes a brass foundry, consisting of two buildings, one 111 feet by 336 feet, and the other a three-story building 200 feet by 34 feet; a galvanizing department, 142 feet by 50 feet, a pipe shop 120 feet by 90 feet, and a two-story storehouse 227 feet by 32 feet.

Six railroad sidings enter the plant at various points from the tracks of the Pennsylvania and the Philadelphia & Reading Railroad.

The Cramp shipyard has always figured prominently in naval construction work, and among the historic vessels built in this yard for the United States Navy were the armored cruisers *New York* and *Brooklyn*, the triple screw protected cruisers *Columbia* and *Minneapolis*, and the battleships *Indiana*, *Massachusetts* and *Iowa*, all of which in their day marked distinct advances in steel warship construction. This yard was no less conspicuous in the early days of the American merchant marine, having built two of the large vessels which have been successfully operated by the American line for over twenty years. These vessels have been followed in later years by a continually increasing number of both merchant and naval vessels of all types, including such vessels as the battleship *Wyoming* and the fast turbine-driven passenger liners *Great Northern* and *Northern Pacific*.

Mathis Yacht Building Company

The Mathis Yacht Building Company and the John H. Mathis Company, located in Camden, N. J., are operated jointly for building all classes of yachts and pleasure boats from 50 to 125 feet in length of wood, as well as for repairing schooners, barges and larger yachts.

At the present time the Mathis Yacht Building Company is turning out high-speed yachts that will make from 25 to 35 miles an hour. These boats average in length from 50 to 60 feet and require double planking. A new building has been put up to take care of the extra amount of this work now on hand. A vessel of special interest now under construction is a 125-foot high-class passenger boat to be equipped with two 150-horsepower Diesel engines. The Mathis Yacht Building Company also has a railway suitable for hauling out yachts and also ample wharfage space for taking care of such vessels.

The John H. Mathis Company has a large marine railway for hauling out schooners, barges and larger yachts for repairs. The water front extends for 1,000 feet along the Delaware, and up-to-date equipment is available for building large wooden vessels. The company now has under construction two 250-foot car floats for the Philadelphia & Reading Railroad.

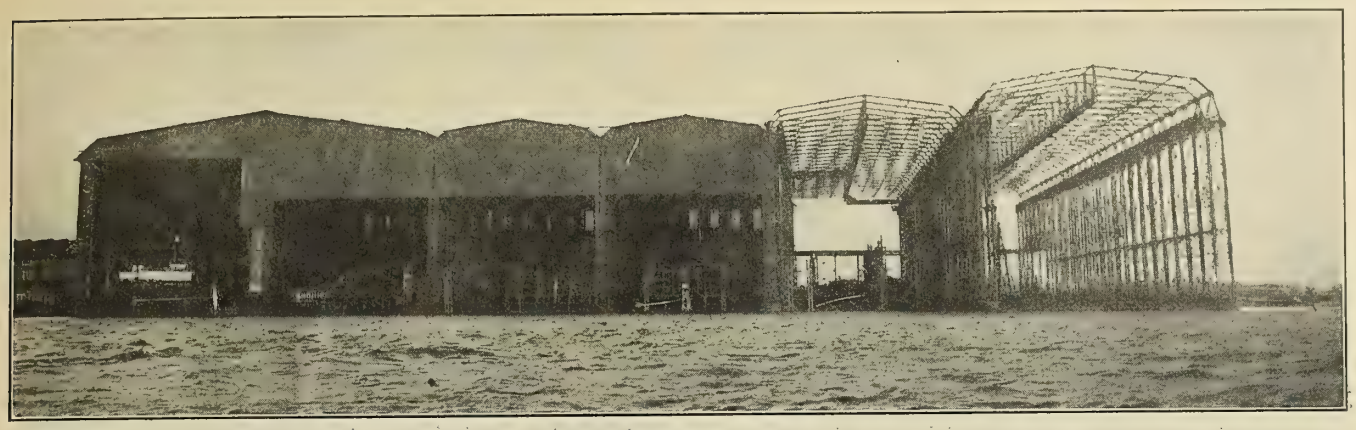


Fig. 1.—New and Old Building Slips of the New York Shipbuilding Company

The New York Shipbuilding Company

Large Shipyard Housed in One Continuous Building—Manufacturing Methods Applied to Ship Construction

The largest amount of tonnage under construction in a single shipyard in the United States at the present time is at the plant of the New York Shipbuilding Company, Camden, N. J., where no less than twenty-eight vessels, twenty-four of which, aggregating 153,913 gross tons, are merchant vessels, and four, totaling 62,180 tons displacement, are naval vessels. The value of the merchant work in hand amounts to about $10,000,000 (£2,050,000), and this, with the naval work, brings the total value of the work up to over $23,000,000 (£4,700,000).

Four thousand men are employed at the yard, and its facilities have been extended by the addition of a new building slip served by two 15-ton cranes. The property on which the plant is located has a water frontage of one-half mile, and there is ample space for doubling the capacity of the yard should the volume of business make further expansion practicable.

This plant is unique in that, with the exception of the woodworking and pattern departments, all of the various shops and building ways are arranged conveniently in one continuous building. The plant was laid out sixteen years ago with a view to applying, so far as possible, manufacturing methods to the construction of vessels. The mold system of structural fabrication was developed to such an advanced degree and the various shops so thoroughly equipped with machinery and traveling cranes and conveyors that the work is carried out with remarkable rapidity with a minimum amount of manual labor.

The compact group of buildings includes a plate receiving and distributing shed where structural material is received and handled by a gantry crane. This shed is adjacent to the boiler, drop forge, angle, plate, machine and blacksmith shops, in which the material is handled by overhead traveling cranes which overrun the gantry crane in the distributing shed.

After the material is fabricated in the shops it is carried directly to the ship ways by low gantries, which deliver the material directly to the overhead cranes over the building slips. At one end of the immense building, adjacent to the building slips, is a fitting-out basin, or wet dock, which is served by an overhead crane of 100 tons capacity capable of handling heavy machinery. This crane can also be transferred to the building slips, so that heavy machinery can be placed on the vessels before launching if desired.

Of the vessels now building at this yard, two are battleships of the superdreadnought type for the United States Navy; two are torpedo boat destroyers; nine are oil tank-

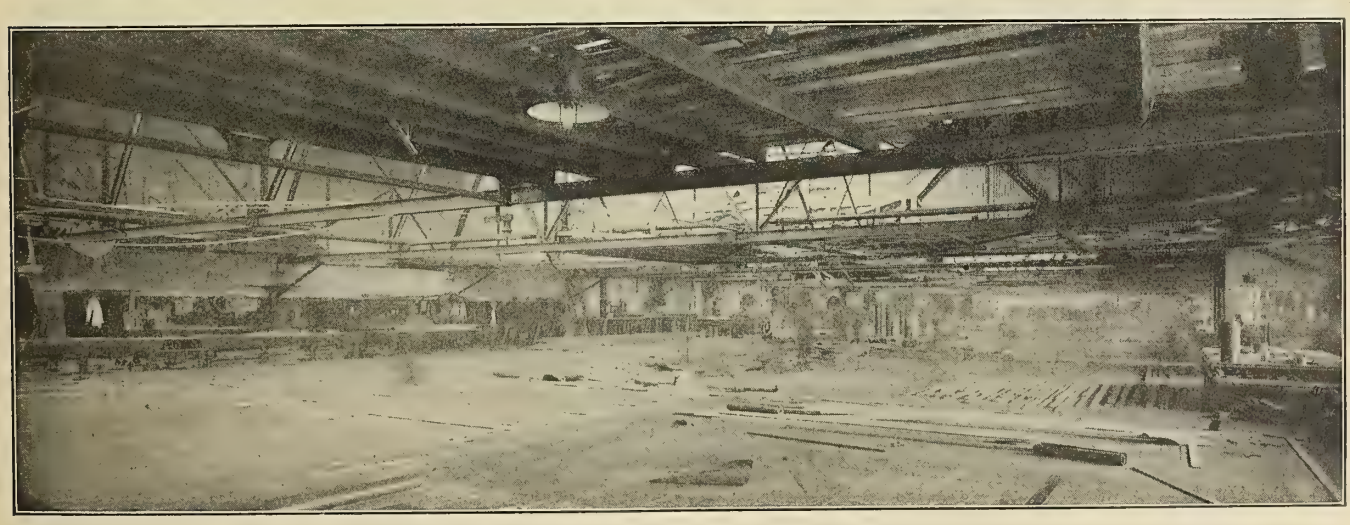


Fig. 2.—Mold Loft of the New York Shipbuilding Company

ers; six are colliers, and eight are car floats. As far as the merchant vessels are concerned, all of the vessels now building are adapted to special trades for carrying cargoes in one direction; for this reason the structural work has been highly standardized, and the result is as nearly a manufactured product as the building of vessels can be. During the sixteen years of its existence the company has built 166 vessels, and, with the present influx of orders, the capacity of the yard for rapid production has been so highly developed that on the average one large vessel is now launched each month.

Staten Island Shipbuilding Company

The Staten Island Shipbuilding Company, Port Richmond, N. Y., which operates two plants, one at Port Richmond, which covers 8 acres, with a water front of 500 feet, and the other at Mariner's Harbor, which covers 20 acres, with a water front of 1,200 feet, is increasing its facilities to build steel ships up to 7,500 tons. The company executes repair work valued at about $1,000,000 (£205,000) each year, and now has under contract the construction of harbor vessels amounting to about $500,-

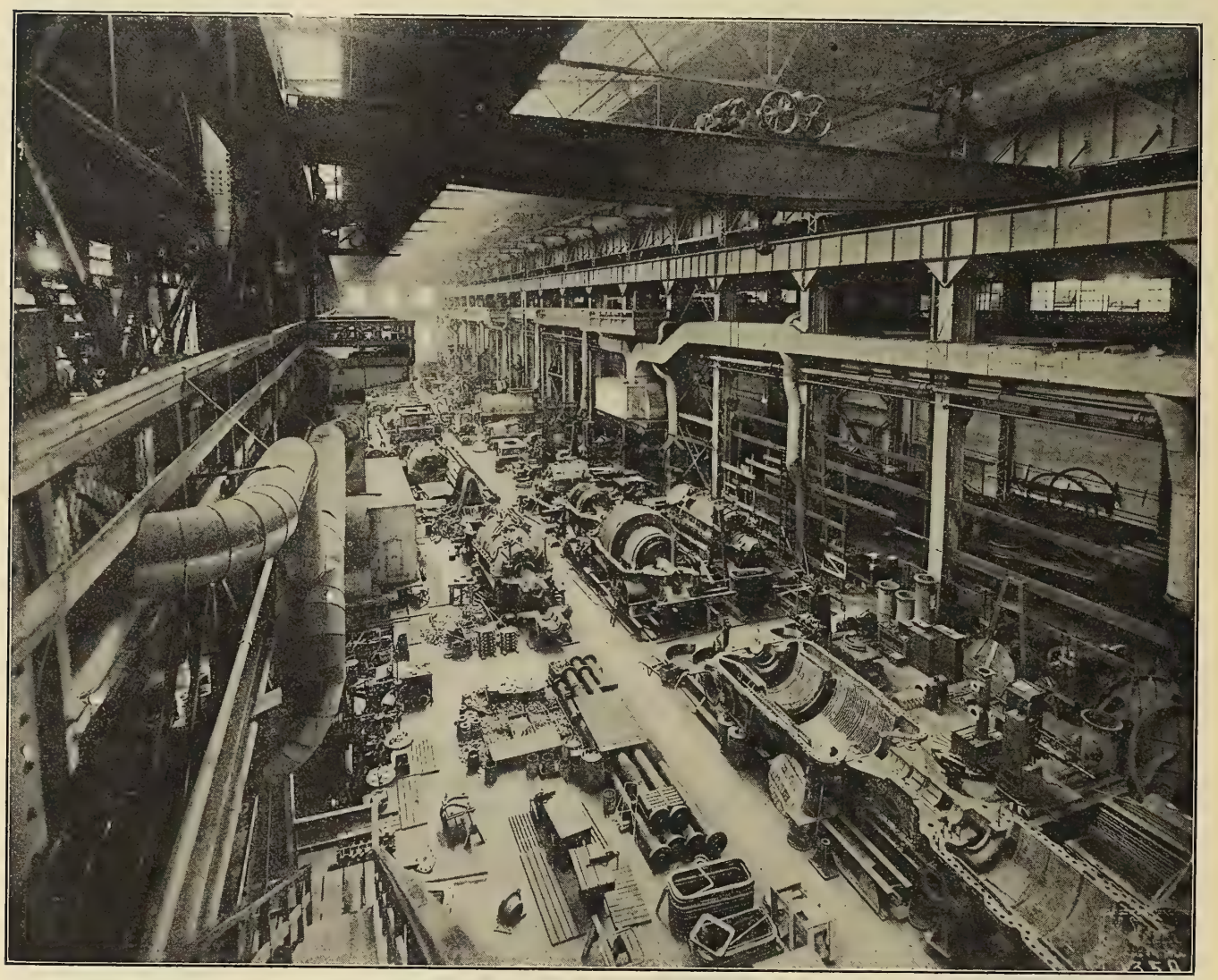


Fig. 3.—Machine Shop of New York Shipbuilding Company

Shipping Destroyed by War Operations

According to reports compiled by the *Journal of Commerce,* approximately 990 vessels of all classes and types, with an estimated gross tonnage of about 1,878,003 tons were destroyed directly or indirectly as a result of the first seventeen months of the European war. England lost 602 vessels of 1,192,551 gross tons; Germany, 65 vessels of 161,888 gross tons; France, 54 vessels of 125,978 gross tons; and Norway, 77 vessels of 103,023 gross tons, while the remaining vessels lost belonged to Denmark, Sweden, Holland, Russia, Greece, Spain, Japan, Italy, Turkey, Belgium, Austria and the United States. Of these, however, only seven vessels, aggregating 14,087 gross tons, were American vessels.

000 (£102,500). The company has not experienced a slack period during the last five years, and regularly employs from 800 to 1,000 men.

The plant at Port Richmond has four building slips capable of accommodating vessels up to 300 feet in length, and three dry docks, the largest of which has a capacity for 3,000 tons. The plant at Mariner's Harbor has three building slips, which are now being equipped for handling vessels up to 7,500 tons, and three dry docks. All of the dry docks are of the floating dry dock type, built of wood, with motor-driven equipment.

At the Port Richmond yard, where the construction consists principally of tugs, barges, lighters and smaller vessels for harbor equipment, the machine shop is equipped with tools which are nearly all new, and has a

capacity for building four engines up to 3,000 horsepower at one time, in addition to the usual repair work. It is proposed to build an erecting shop at the end of the machine shop, which will increase its capacity so that engines up to 4,000 horsepower can be built. The boiler shop at this plant has a capacity for turning out twenty Scotch boilers per year. For repair work there is an electric welding plant and seven gas machines for cutting. It is proposed to build a plant for generating gases for these machines. All of the shops at this plant, except the boiler shop and power plant, are of wood, and all of the shops are equipped with automatic sprinklers.

Formerly the Mariner's Harbor plant was used exclusively for the construction and repair of wood vessels, but at the present time the plant is being fitted up for the construction of large steel ships. For this purpose a ship shed and the necessary yard tools and cranes will be provided. The machine shop is 100 by 40 feet, and near the plant an iron foundry 100 feet by 100 feet, with a capacity of 10 tons, is being erected.

Power at both yards is generated by producer-gas power plants built by the company. The power plant at the Port Richmond yard is of 1,000 horsepower, and that at the Mariner's Harbor yard 500 horsepower. All of the machinery in both plants is operated by electrical drive.

In addition to its shipbuilding and repair work, the company is now perfecting a marine oil engine of the semi-Diesel type, which will be on the market in about six months.

Material is brought to the yards by rail, and in addition the company owns two auto trucks of 3½ and 1½ tons capacity, respectively, and two gasoline (petrol) launches for the delivery of supplies.

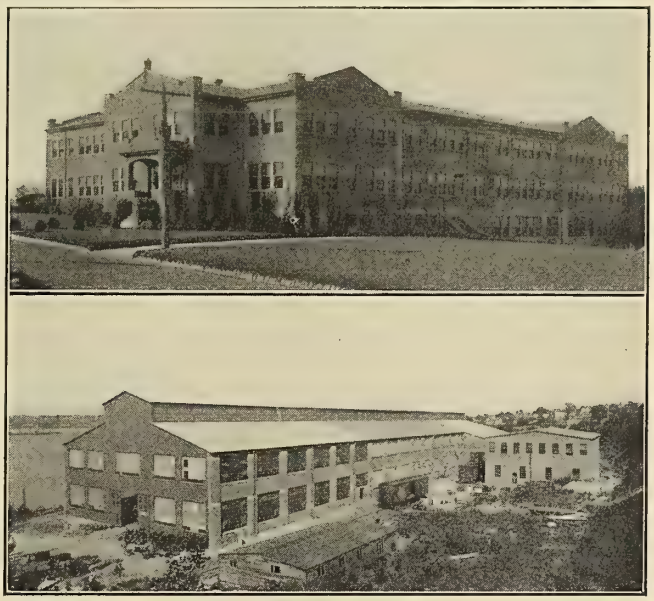
Progressive American Diesel Engine Building Company

The first firm in the United States to take up on an extensive scale the construction of heavy oil engines of the Diesel type for marine purposes was the New London Ship & Engine Building Company, Groton, Conn. As first organized, the company was capitalized at $500,000 (£102,500). The plant, consisting of an engine-building shop 106 feet long, was placed in operation in May, 1911. Additions to the plant were made in 1912, and again in 1915, and the capitalization of the company has been increased to $3,500,000 (£717,500). At present 1,000 men are employed, working day and night in two twelve-hour shifts. That the plant has been eminently successful is shown by the fact that four months after operations were begun a 2 percent quarterly dividend was paid, and since that time this quarterly dividend has never been passed.

At the present time the plant consists of the main machine shop, 600 feet long, one-half of it being 130 feet wide and the other half 100 feet wide. The building is of monitor construction, with the center bay served by a 25-ton capacity traveling crane. In addition to the main engine-building shop there is a two-story pattern shop, 60 feet by 70 feet, and a pipe shop, 50 feet by 120 feet. A new foundry, 180 by 80 feet, is now being constructed, and within about two months the first castings will be made. The company also contemplates building a forge shop, and a larger pattern and pipe shop, as well as a new storehouse.

The property on which the plant is located, which is the site of the former Eastern Shipyard, where the Great Northern 13,323-ton steamships *Dakota* and *Minnesota* were built twelve years ago, covers 33 acres, and at the north end of the property there is ample room for the construction of hulls for motor ships. There is a depth of 18 feet of water at the end of the company's dock, and, with the space and equipment available, the plant should be an ideal place for the construction of large motor ships, a type of vessel which is rapidly gaining favor among American shipowners.

The major output of the company up to date has been Diesel engines for submarines built by the Electric Boat Company. The company can build units up to 3,000



Upper View—Office Building of the New London Ship & Engine Building Company and of the Electric Boat Company
Lower View—Shops Where the Nlseco Diesel Engine is Built

horsepower, and during the last ten months 175 Diesel engines, aggregating about 50,000 horsepower, have been turned out. Forty engines of 240 horsepower each were built in four months and ten more are now under construction. The company is now building two 360-horsepower engines, and about two years ago nine small 100-horsepower engines were built and kept in stock for sale. All except two of these engines have been sold and installed principally in work boats.

F. O. Smith Shipbuilding and Dry Dock Company, Inc.

One of the busiest repair yards at Norfolk is the F. O. Smith Shipbuilding & Dry Dock Company, Inc., which employs between 100 and 200 men, and now has on hand work valued at about $40,000 (£8,200). The plant originally had a floating dry dock with a capacity of 2,000 tons, but during the last year a third section has been added to this dock, increasing its capacity to 3,000 tons. The company's marine railway, which is 225 feet long and has a capacity of 1,000 tons, has also been rebuilt with a new foundation, chain gearing, etc., making the expenditures for improvements amount to approximately $75,000 (£15,370).

While the plant is equipped for building tugs and barges, it makes a specialty of general repairs to steel and wooden vessels. It is conveniently located near the center of the city and is completely equipped with electricity, compressed air and oxy-acetylene and electric welding plants.

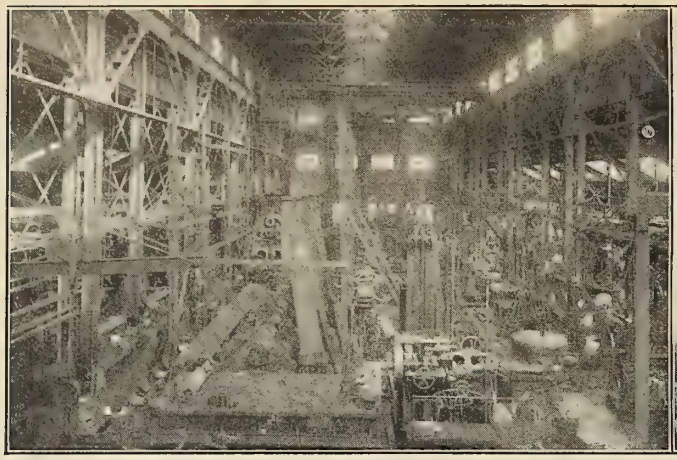


Fig. 1.—Interior of Old Machine Shop

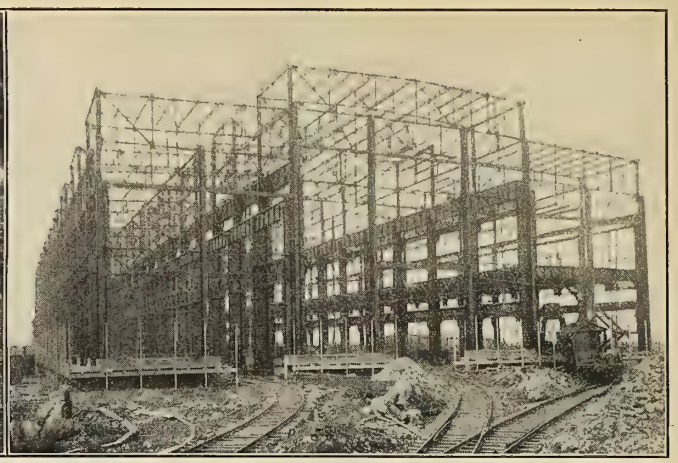


Fig. 2.—New Machine Shop Under Construction

Shipyard of the Maryland Steel Company

Extensive Additions Under Way to Meet Increased Orders for New Merchant Ships—New Building Ways and Shops

Nine months ago the marine department of the Maryland Steel Company, Sparrows Point, Md., which is the tidewater plant of the Pennsylvania Steel Company, had under contract nine vessels valued at about $4,500,000 (£922,500), and for this work was employing 2,400 men. To-day the company has under construction thirteen vessels, aggregating over 75,000 gross tons, valued at about $10,500,000 (£2,150,000). The company is now employing 3,500 men.

On February 18 a formal announcement was made that the Pennsylvania Steel Company had passed into the hands of the Bethlehem Steel Corporation. The shipyard of the Maryland Steel Company, therefore, has become a subsidiary of the Bethlehem Steel Corporation, making the fifth large shipyard controlled by this corporation.

Needless to say, the company's facilities are taxed to the utmost, and in order to meet the situation the company is making extensive additions to its equipment. One of the first changes made in the yard was the combination of two small building ways into one large one capable of accommodating vessels up to 550 feet long by 72 feet beam. In addition to this, an entirely new ways has been constructed capable of handling vessels up to 650 feet long by 78 feet beam.

For handling material on the new ways four electrically operated traveling power cranes of 12½ tons capacity

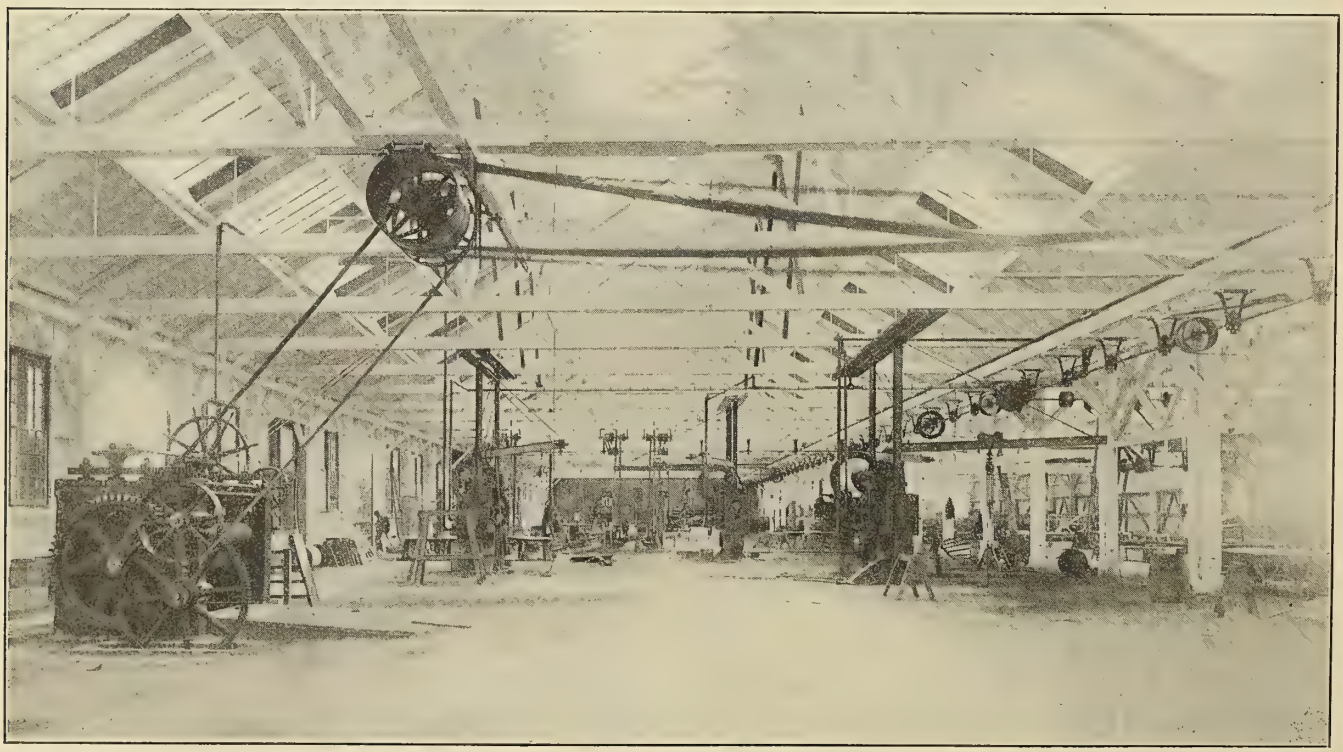


Fig. 3.—Interior of Old Plate and Punch Shed

and a similar crane of 15 tons capacity have been installed by the Alliance Machine Company, Alliance, Ohio. As shown by the photographs, these cranes operate on specially built tracks adjacent to the ways. The material is conveyed to these cranes by a 10-ton crane traveling across the head of the ways.

At present the yard has six building ways. Slip No. 1 is capable of taking vessels up to 350 feet long by 46 feet beam. Slips Nos. 2, 3, 4 and 5 can accommodate ships up to 550 feet long, and, with the exception of slip No. 3, can accommodate ships up to 72 feet beam. Slip No. 3 can accommodate vessels up to 62 feet beam, while slip No. 6 can accommodate vessels 650 feet long by 78 feet beam.

In addition to the changes to the building slips, a large new machine shop and a large ship platers' shed are being erected. The new machine shop will be 425 feet long and 180 feet wide, while the new ship plater's shed will be 600 feet long and 75 feet wide. Between the ship shed and the boundary line of the company's property new storage racks are being erected, to be served by traveling cranes.

Besides hull work, the plant is fully equipped for building boilers, engines, auxiliary machinery, joiner work and fittings, so that practically the entire ship can be built in

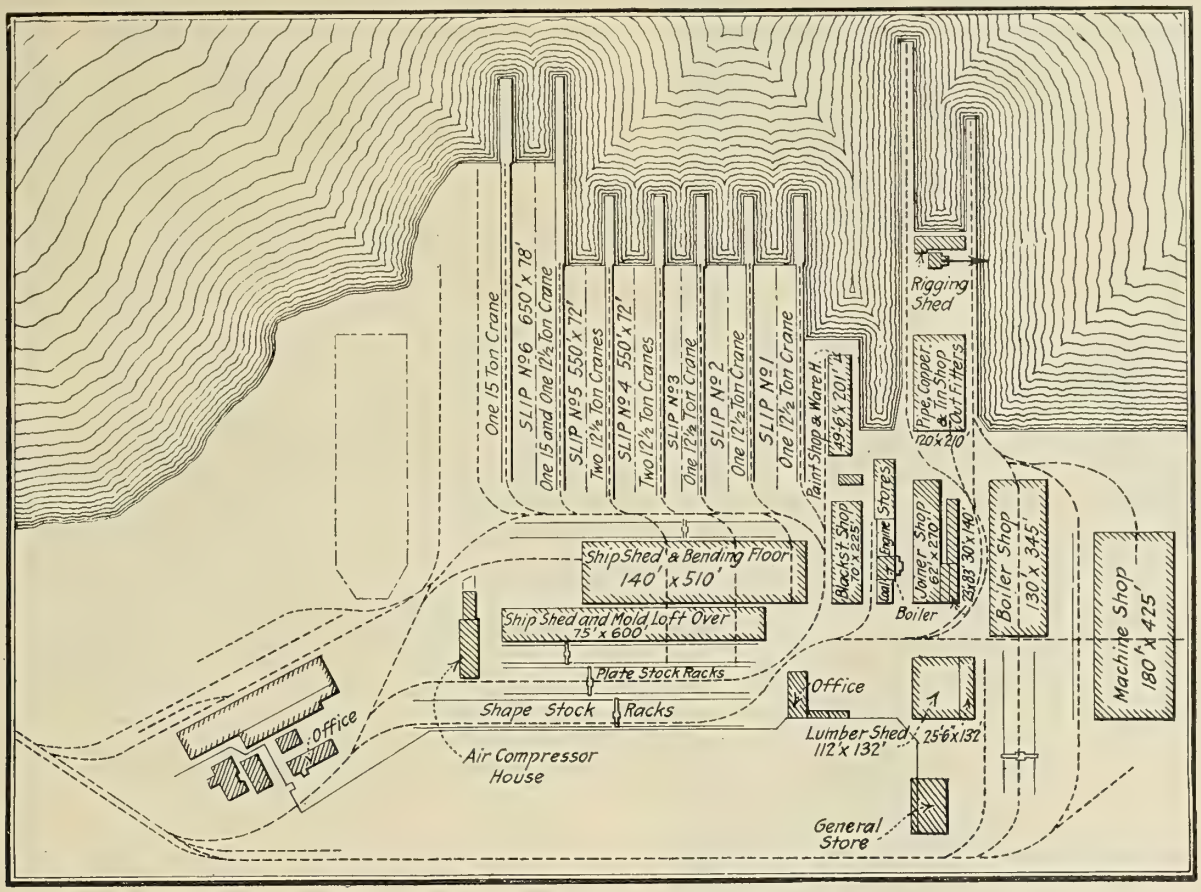


Fig. 4.—General Plan of the Shipyard of the Maryland Steel Company, Sparrows Point, Md.



Fig. 5.—New Electric Tower Cranes

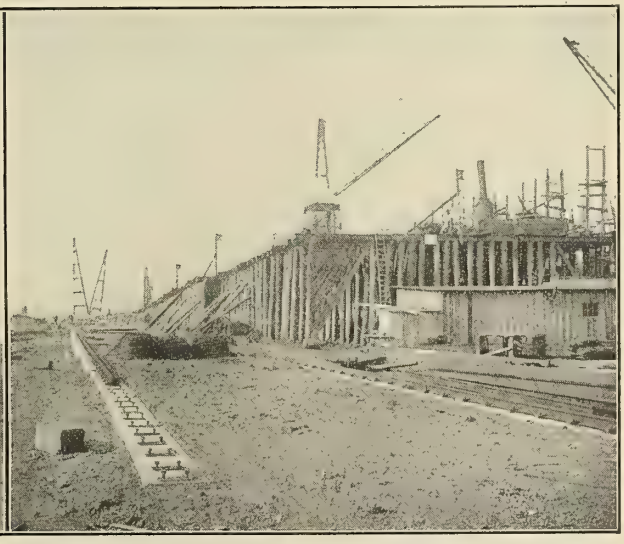
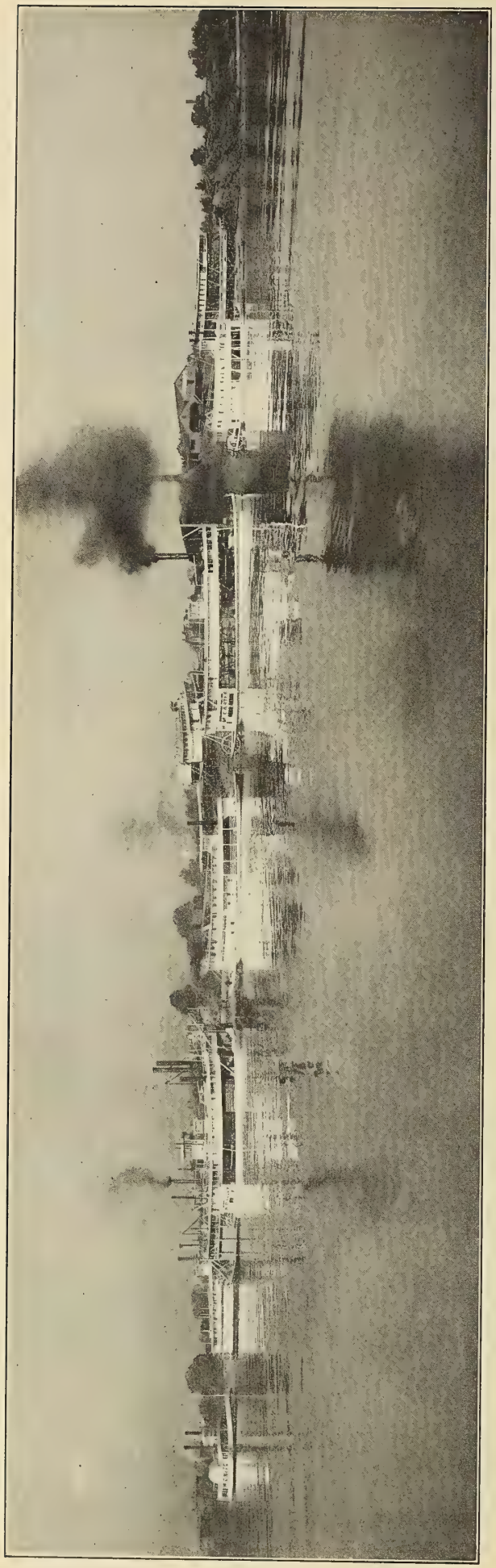


Fig. 6.—New Building Ways



General View of Plant of Howard Ship Yards Company on the Ohio River at Jeffersonville, Ind., Showing Types of River Steamboats Built

the yard. The shops include boiler and machine shops, a blacksmith shop, pattern shop, carpenter and joiner shop, paint shop, coppersmith shop, tinsmith shop and outfitting and rigging shops. The equipment and facilities of the plant are modern and complete in every respect. As a result, the company has been able to establish an enviable record in the rapidity of ship construction.

During recent years all classes of vessels have been built at the yard, including ocean-going passenger ships, freighters, ferry boats, tug boats, barges, yachts, car floats and steam lighters, colliers, torpedo boat destroyers, bay and river steamers, dredges and oil tankers.

Docking Facilities at New Orleans, La.

The New Orleans Dry Dock & Ship Building Company own and operate two new floating dry docks, modern in every respect; one of 5,000 tons capacity and one of 2,000 tons capacity and a full supply of pneumatic tools with full-powered air compressors to operate same. Electric current is supplied to all parts of the docks for light and power. Ample wharf room on the premises is available for vessels while under repair, with no charge for same. Good calkers and carpenters are always on hand with careful supervision of work. Saw and planing mills and blacksmith shops are on the premises.

These dry docks have no interest in any foundry or machine shop; all foundries and machine shops in this vicinity work on these docks. Competitive bids on all classes of machine work can be had from any or all of them, thus insuring reasonable rates.

The United States Navy Department maintains in New Orleans, a first class floating dock of 18,000 tons capacity. This dock, while not competing for commercial work within the capacity of the New Orleans Dry Dock & Ship Building Company's docks, is available for commercial purposes for all vessels beyond the capacity of the New Orleans Dry Dock & Ship Building Company's largest dock, which is 5,000 tons.

Therefore New Orleans stands in the position of being able to take care of any vessel up to 18,000 tons, and as no vessels larger than this have ever entered this port or are in ordinary commercial use in the Gulf, it places New Orleans, as to docking and repairing facilities, in advance of any other port in the Gulf or on the Atlantic Coast, except New York and Newport News.

Shipyards on the Western Rivers

Prominent among the shipyards on the western rivers of the United States where steel and wood light-draft river steamers are built, are the Howard Ship Yards Company, at Jeffersonville, Ind., the James Rees & Sons Company, Pittsburgh, Pa., Charles Barnes & Company, Cincinnati, Ohio, Johnston Bros., Ferrysburg, Mich., and the American Bridge Company, Pittsburgh, Pa. The types of vessels built at these yards include stern and side wheel paddle steamers, screw propeller boats with tunnel sterns, and barges of all descriptions of both steel and wood. On account of the peculiar conditions existing on the large western rivers these vessels are of necessity of light draft, and, where the vessel is for packet service, of comparatively high speed. Recent developments in river boat construction have led in some cases to the adoption of internal combustion engines for the propelling machinery and a general simplification in the design and construction of hull work, so that a modern steel self-propelled barge for the Ohio or Mississippi rivers bears only slight resemblance to the older type of stern wheel steamboat.

The Merrill-Stevens Shipyard, Jacksonville, Fla.

With the general industrial awakening of the South, the art of shipbuilding has not been neglected—even in the far South. Jacksonville, Fla., is the home of a very thriving shipbuilding plant owned by the Merrill-Stevens Shipbuilding Company, which was organized in 1887 and is now under the direct management of its three founders. While this company has been engaged hitherto in marine repair work and dredging and wrecking operations, it has recently acquired property across the St. John's River from its present site for the purpose of establishing a plant for the construction of hulls alone. The equipment for this plant has already been obtained, and the new plant will be opened as soon as the volume of new work warrants it.

Meanwhile the present plant is undergoing a change, from steam drive to electric individual drive. A powerful air compressor plant has already been installed and all the machinery about the yard is gradually being adapted for individual electric drive. As the power is to be supplied by a municipal power plant at a very low rate, it is the plan eventually to eliminate the steam power of the plant entirely and substitute compressed air for operating the steam hammers in the blacksmith shop.

The company is at present engaged in building its eighty-eighth hull. Among the vessels built at the yard are the Clyde steamer *Osceola* and the ferryboat *South Jacksonville*. Some idea of the extent of repair work undertaken by the company is shown by the fact that the steamship *Colorado* of the Mallory Line, which was burned at sea last summer, is being converted into a tramp freighter.

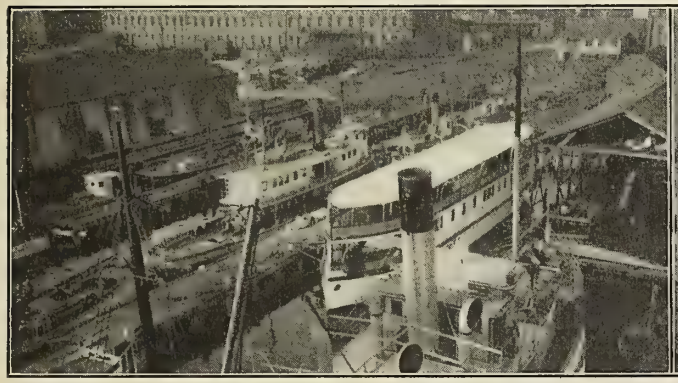


Fig. 1.—Corner of the Merrill-Stevens Plant

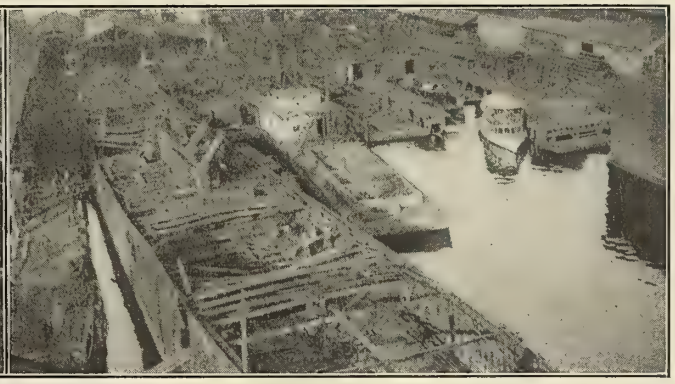


Fig. 2.—Burned Hull of the *Colorado* Being Rebuilt



Fig. 3.—S. S. *Osceola*, Built by the Merrill-Stevens Company



Fig. 4.—Merrill-Stevens Floating Dry Dock

The equipment of the yard consists of the usual machine, blacksmith, boiler, carpenter shops, etc., and there are five dry docks, the largest of which is a floating dry dock of 4,500 tons deadweight capacity. The other docks are of 500, 200, 30 and 15 tons capacity, respectively.

Spedden Shipbuilding Company

Founded by the late Captain R. M. Spedden, the Spedden Shipbuilding Company was incorporated in 1898 for building and repairing ships, engines and boilers. The plant consists of two building berths and a railway dry dock of 1,200 tons capacity, with a length of ways of 200 feet, a machine shop, boiler shop, smith shop, mold loft, pattern and joiner shop and a 600-foot wharf where the depth of water is 20 feet.

The machine shop is 50 feet by 90 feet, equipped with lathes, planers, shapers, drill presses, horizontal and vertical boring mills, milling machines, pipe and bolt cutters, cold saws and other equipment. A traveling crane runs the entire length of the shop, serving the heavy machines and erecting floor. Boom cranes are used for handling work at the light machines.

The boiler shop is 60 feet by 90 feet, equipped with a bull riveter, large and small power punches and shears, large and small steam-driven plate rolls, a plate planer and all classes of air tools. A traveling crane runs the entire length of the shop, while the bull riveter is served by an independent traveling crane. Boom cranes serve the other tools.

The smith shop is 30 feet by 60 feet, equipped with steam hammers, six forges, power press and a full equipment of smith tools. The pattern and joiner shop is 30 feet

by 75 feet equipped with band saws, a planer and jointer. The mold loft covers an area of 90 by 110 feet.

Compressed air is used for drills and hammers and serves the entire plant, including the whole length of the wharf. Water pipes extend the length of the wharf for filling boilers and tanks, after repairs have been executed. Electric lights are installed throughout the plant and wharf.

The yard equipment consists of power punches, shears, plate rolls and a fuel oil furnace, 36 inches wide by 30 feet long, with face plates 25 feet by 35 feet located in front of the furnace. The furnace and all tools are served by boom cranes, while the launching ways, which are 150 feet and 200 feet long, respectively, are served by mast and locomotive cranes. The marine railway is also served by mast cranes.



Spedden Shipbuilding Plant



Valk & Murdock's Marine Railway

At the present time the company is rebuilding a tug boat and a ferry boat, converting a steamer into an ocean-going barge and building a 160-foot tug boat of 1,000 horsepower, a 125-foot tug boat of 600 horsepower, and a gasoline (petrol) driven 60-foot oil barge of 70 horsepower, bringing the total value of work in hand up to about $300,000 (£61,600). Two hundred men are now employed at the yard, but this force will be materially increased upon the arrival of material now on order.

Valk & Murdock Company

The plant of Valk & Murdoch Company, Charleston, S. C., has a water front of 630 feet, and the yard extends back 700 feet from the water front. At the head of the company's wharf, which is 320 feet long by 20 feet wide, there is a depth of water of 30 feet. The equipment includes a boiler shop 200 feet long by 50 feet wide, with a 30-foot wing extending the entire length of the shop, giving a floor space of 200 feet by 80 feet; a machine shop 150 feet long by 50 feet wide; a foundry, 60 feet by 40 feet; a forge shop, 60 feet by 30 feet; a coppersmith shop and two marine railways, one of 1,600 tons capacity, 220 feet long by 55 feet wide, and the other of 200 tons capacity.

The boiler shop is equipped with a 40-ton electric traveling crane in the main building and a 5-ton and a 1-ton traveling crane in the wing. The riveting plant consists of a hydraulic riveter with a gap of 12 feet 6 inches, capable of exerting pressures of 25, 50, 75, 100, 125 and 150 tons. This machine is served by a 25-ton hydraulic crane. The shop equipment also consists of two large radial drills; one drilling and countersinking drill with a 15-foot arm; a heavy punch with a 42-inch gap; also a 36- and a 30-inch gap punch; a plate planer, two horizontal and one vertical rolls, as well as pneumatic riveters and drills supplied with air from four air compressors with a combined capacity of 1,250 cubic feet.

The machine shop is equipped with seven lathes up to 72 inches swing, a large boring mill, two 48-inch radial drills and one upright drill, portable boring bars up to 48 inches capacity, a 36-inch by 12-foot planer, two shapers, one slotter, emery grinders, a portable crane, two bolt cutters up to 3 inches capacity, and pipe cutters up to 6 inches capacity, all being driven by electric motors.

The forge shop contains a steam hammer with crane and four forges. The foundry is of 5 tons capacity, with a steam hydraulic crane, core ovens, brass furnace and two cupolas of 6 tons capacity each. There is also a fireproof pattern storage building, and the company's wharf is equipped with air and water mains extending the full length of the wharf and also around the marine railways. Railway connections extend to the head of the wharf and through the yards, connecting with all the railroads entering the city. A 15-ton Brown traveling crane serves the yard, wharf and railway.



Valk & Murdock Boiler Shop

Chester Shipbuilding Company

The Chester Shipbuilding Company, Chester, Pa., which has acquired the site of the old Roach shipyard in Chester, has entirely refitted the yard with new machinery and equipment for the construction of merchant vessels, and now has under construction six oil-carrying vessels of 5,000 tons gross each for foreign owners and a freighter of 4,000 tons for American ownership. The oil tank steamships are from 400 to 450 feet in length.

As this yard is equipped only for the construction of hulls, contracts for the propelling machinery of all vessels built at the yard are sublet to outside firms.

Baltimore Shipbuilding Plant Reorganized

New Buildings and Machinery for Ship Construction and Repairs Installed by the Baltimore Dry Docks & Shipbuilding Co.

Expenditures of about $200,000 (£41,000) for repairs and improvements have recently been made by the Baltimore Dry Docks & Shipbuilding Company at its plant in Baltimore, and the yard is now engaged to capacity in building and repairing steam vessels. While this plant was established nearly half a century ago as the Columbia Iron Works, and was later known as the Skinner Shipbuilding & Dry Dock Company, it was entirely reorganized a year ago and incorporated under its present name. Since the reorganization new machines have been installed in the old shops, extensive repairs have been made to the dry docks and piers at the two yards operated by the company, and a new steel shop 220 feet long by 60 feet wide has been constructed; also two new building slips with overhead traveling cranes have been completed, giving the company two large slips where vessels can be built economically.

The two plants operated by the company are known as the upper plant and the lower plant. The upper plant is located at the foot of Belt and Cross streets, Baltimore, and includes in its equipment a 600-foot dry dock with a floor width of 62 feet and 22½ feet depth of water over the sill. This dock was completed in 1902 and cost nearly $500,000 (£102,500). There are also two marine railways, a shipbuilding berth, saw mill and various shops and office buildings at this plant.

At the lower plant, located at Locust Point, there is another dry dock, 437 feet long, with a floor width of 50 feet and 22½ feet depth of water over the sill. At this plant are three shipbuilding berths with traveling locomotive cranes, platers and smith shop, a carpenter and joiner shop, mold loft, brass foundry, machine shop, boiler shop, coppersmith shop, pipe shop, paint shop, storerooms, tool rooms, power house and office building.

The company now has contracts for the construction of seven bulk oil tankers for Cristoffer Hannevig, Christiania, Norway, four of the vessels to be equipped with heavy oil engines, and the other three with geared turbines. Each vessel will cost about $500,000 (£102,500). In carrying out this work the company will employ from 1,000 to 1,200 men. In addition, the company is building a seagoing dredge, the *San Pablo,* for the engineer de-

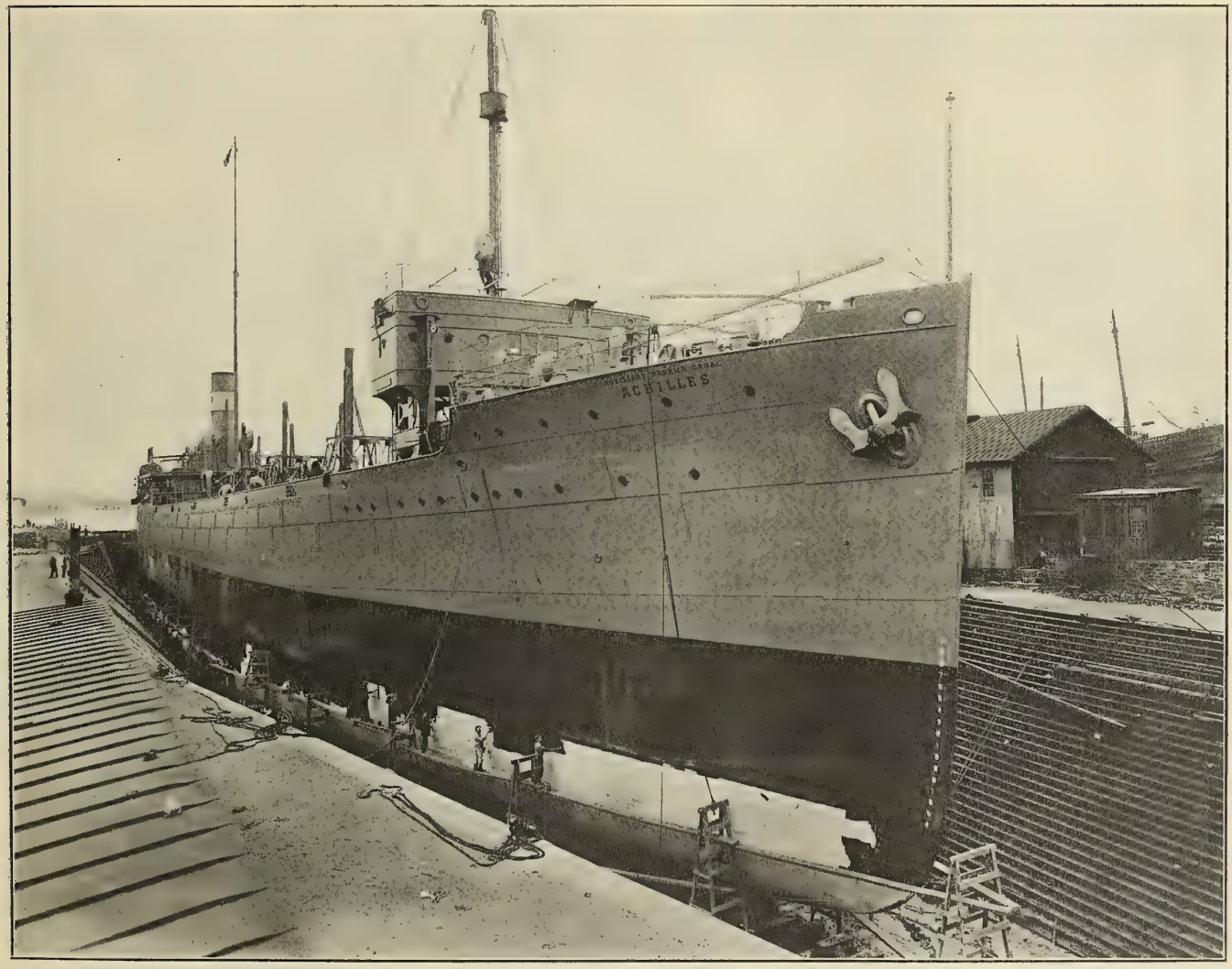


Fig. 1.—Panama Collier *Achilles* Being Cleaned and Painted in the Upper Dock of the Baltimore Dry Docks & Shipbuilding Company



Fig. 2.—Waterfront of Baltimore Dry Docks & Shipbuilding Company's Plant

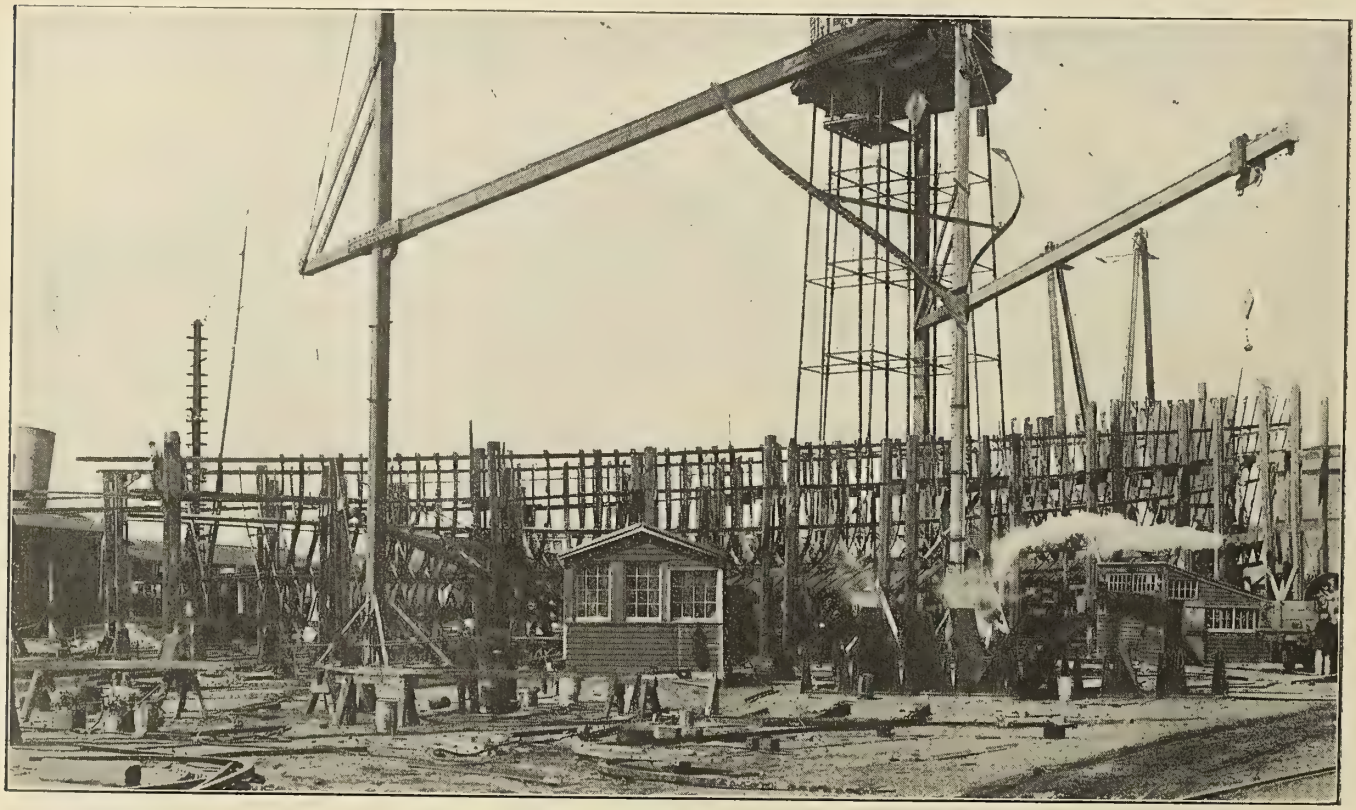
partment of the United States Army. Ninety-five percent of the vessels which ply to Baltimore can be accommodated in the company's largest dry dock, and on account of its location and equipment a large volume of marine repair work is carried out each year. The Panama collier *Achilles* is shown in the 600-foot dock in Fig. 1, while Fig. 2 shows the busy aspect of the yard at present.

Pusey & Jones Shipyard

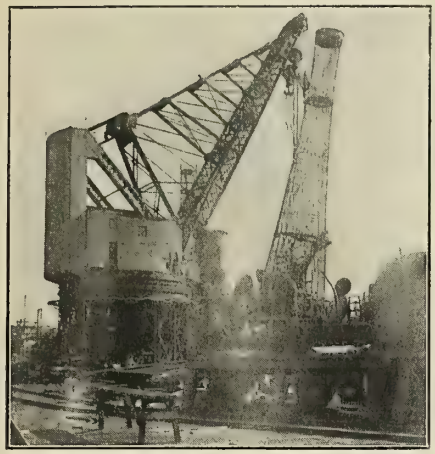
The shipyard of the Pusey & Jones Company is located on the banks of the Christiana at Wilmington, Del., about a mile and a half from the Delaware River. On one side is the Pennsylvania Railroad main line, with spur tracks entering the plant in two lines, one of which comes alongside a landing platform the full length of the storehouse.

There are four shipbuilding ways and a marine railway. Vessels up to 250 feet can be handled, and up to this limit some of the finest yachts in the country have been built. This firm built the first iron sailing ship, the *Mahlon Betts,* and the yacht *Volunteer,* which defended the "America" Cup.

The work at present on hand consists of two lightships for the Bureau of Lighthouses, three derrick barges for the Pennsylvania Railroad, two harbor tugs for the New York Central Railroad, and one harbor tug for the Philadelphia & Reading Railway.



Vessel in Frame at Pusey & Jones Shipyard



Newport News Shipyard and Repair Plant

Marine Work, Valued at Nearly $30,000,000, Now Under Construction by the Newport News Ship= Building and Dry Dock Company

CONVINCING evidence of the revival of shipbuilding in the United States is found in the fact that the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., now has under construction work valued at nearly $30,000,000 (£6,150,000), consisting of nineteen vessels, seventeen of which are merchant vessels, aggregating 128,000 gross tons, and two battleships of 63,400 tons displacement, making in all nineteen vessels of over 191,000 tons, to say nothing of a large amount of repair work, which forms an important part of the company's annual business. The company now has on its pay roll 7,000 employees, as against 4,100 a year ago, and is making expenditures amounting to $400,000 (£82,000) for improving equipment and replacing old machinery and buildings.

That the company has maintained a very large volume of repair business, in addition to its construction work, is shown by the fact that since the plant was started in 1886 between 3,000 and 4,000 vessels have been docked in its three large dry docks. During the year ending December 31, 1915, the number of arrivals at the shipyard piers was 657. The raw material used by the plant each year in-



Fig. 1.—Holland-America Liner *Rotterdam* in Dry Dock No. 2 of Newport News Shipbuilding & Dry Dock Company, Newport News, Va.

cludes in round numbers 55,000 tons of structural steel, including plates, shapes, bars, forgings and sheets; 5,000 tons of iron, steel and copper castings, 38,000 tons of coal, 550,000 gallons of fuel oil and 8,000,000 feet, board measure, of lumber.

The plant now occupies an area of about 125 acres and has a deep-water frontage of about one-half mile. When the plant was started in 1886 a large basin dry dock, known at present as dry dock No. 1, was built, and subsequently shops and other equipment were added, so that at the present time the equipment is thoroughly modern and includes shops and tools capable of undertaking any kind of marine work pertaining to the construction or



Fig. 2.—Shipyard Dispensary

repair of hulls, engines, turbines or boilers. Electric, hydraulic and pneumatic power are used for driving the tools of various kinds, the power being supplied by a central power plant developing about 5,000 horsepower.

In view of the fact that 1915 was the most eventful year in the history of the plant, and that the prospects for the present year are even better, extensive additions have been planned, including the erection of a new machine shop, an administration building, a luncheon room, as well as the replacement of the old boilers in the power plant by watertube boilers with automatic stokers, and the addition of a new craneway with 10-ton cranes for handling plates and shapes. New brick buildings are also to replace some of the old wooden buildings. All of this work has been planned by the company's own engineers and covers practically every department of the yard.

The yard now has seven shipways, six of which are covered by cantilever cranes running on trestles. Across the ends of these ways longitudinal carriers now in course of construction furnish quick conveyance of material to any particular shipway.

There are three basin dry docks now in use, the dimensions being as follows:

	No. 1 Feet	No. 2 Feet	No. 3 Feet
Length over all.....	639	861	585
Width at top of dock.....	130	162	147
Depth of water over sill.....	25	30	24

The largest fitting-up basin is 764 feet by 250 feet between piers Nos. 2 and 3, and on the pier, forming one side of this basin, is a 150-ton revolving crane. The smaller fitting-out basins are provided with shear legs or fixed derricks, and, in addition, floating derricks are available for installing heavy weights on ships afloat.

The machine shop, an interior view of which is shown in Fig. 4, is approximately 560 feet long by 101 feet wide. In the last few years special machinery, much of it designed and built in the works of the company, has been installed for the rapid and economical construction of turbines.

The ship shed, framing shed and kindred departments are grouped adjacent to the building slips. The machine, boiler, blacksmith, copper and outfitting shops form another group, while the joiner and pattern shops, lumber shops, fireproofing plant and saw mill are all near each other. The framing shed, located at the head of the slips, is 270 feet by 344 feet, and at each side of the framing shed is a ship shed served by a cantilever crane, which can transport fabricated material to points where it can be picked up by the cantilevers serving the building slips. The ship sheds are 320 feet by 60 feet and 400 feet by 72 feet, respectively.

In addition to the operations at the shipbuilding plant, the company operates two large foundries, one for steel and iron castings and the other for brass work. These foundries are located near the shipyard and are connected directly to it by railroad tracks.

Work for the welfare of the employees has claimed the most earnest consideration of the management of the yard. It is believed that the colored Y. M. C. A., recently organized at the yard, is the first of its kind in any industrial plant in this country, and the results of this work have been most gratifying, especially in the item of regular and constant attendance on the part of the colored employees. On January 1, 1915, the company announced a

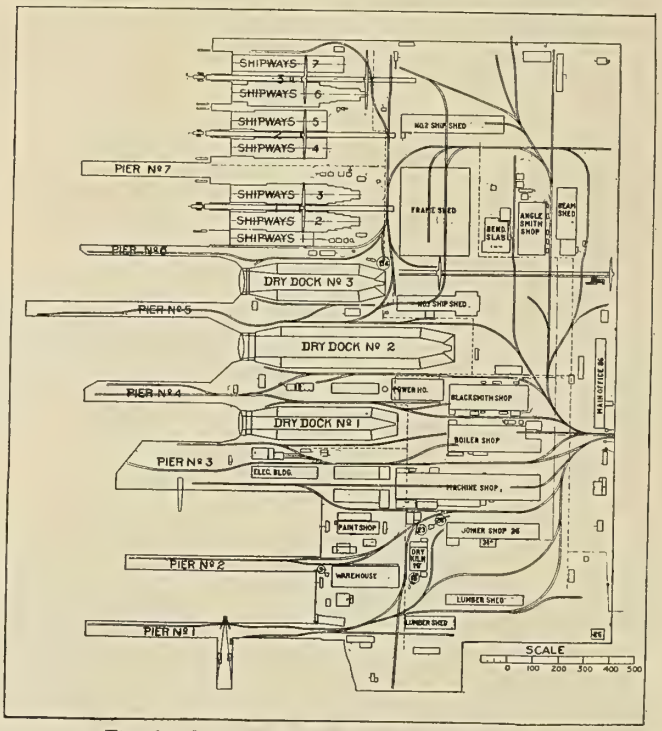


Fig. 3.—Layout of the Newport News Yard

plan for retirement allowances for its employees who have reached retirement ages, and a number of employees are now receiving such allowances. The company has also just finished the construction of a dispensary inside the plant, where a surgeon and nurse are in constant attendance, so that immediate attention can be given to any cases of accident or sudden illness.

The keel of the first vessel constructed at this yard was laid down in June, 1890. Since that time the yard has constructed 182 vessels of all classes, and, as stated above, now has under construction no less than nineteen vessels, including two superdreadnoughts for the United States Navy, eight large oil-tank steamships, eight freight steam-

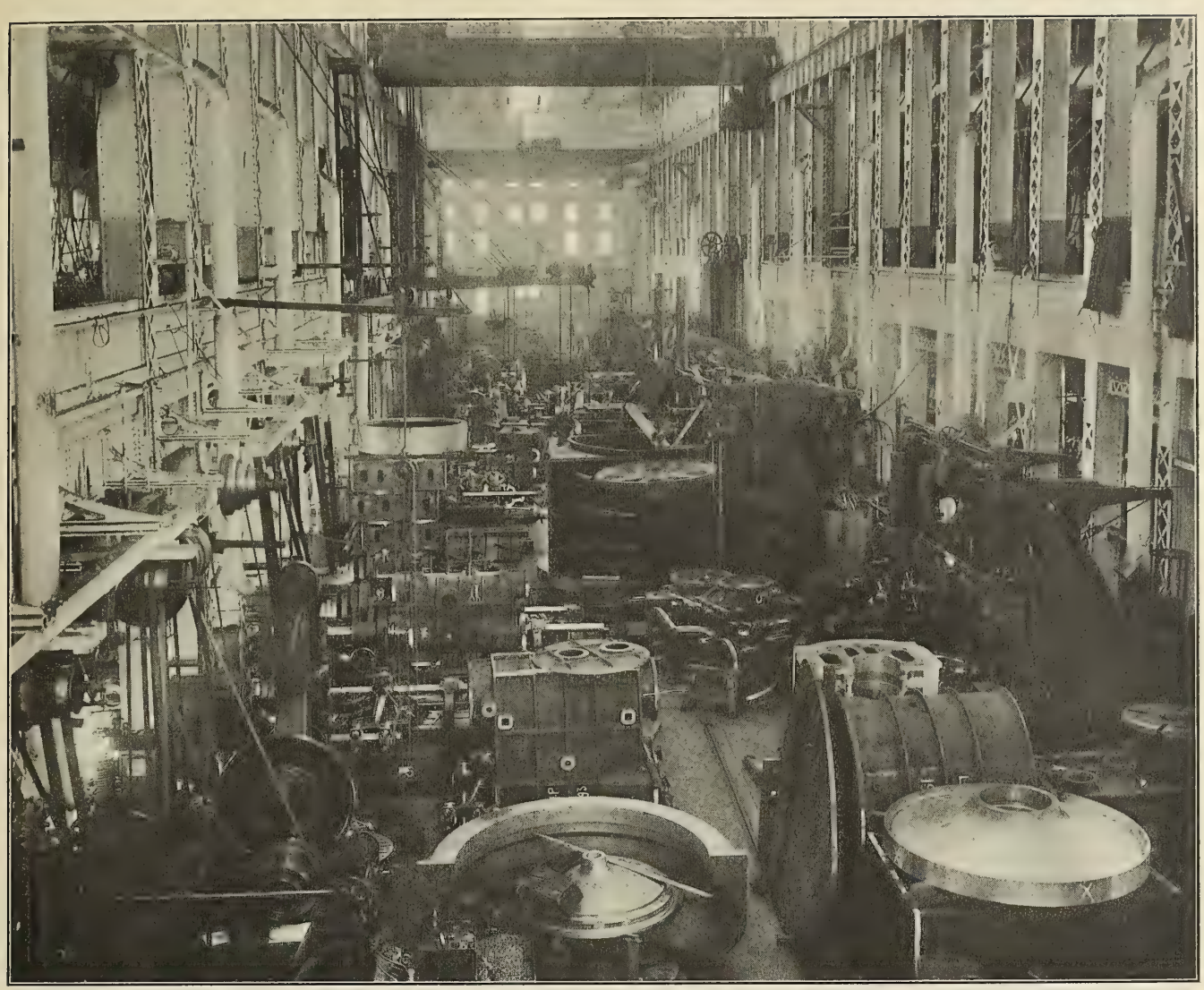


Fig. 4.—Interior of Newport News Machine Shop

ers and a passenger and freight steamer. Only once in the history of the plant has the volume of construction now in hand been exceeded; that was in 1905, when the company was building six warships for the Government. As far as merchant-vessel construction is concerned, the production of 1915 has never been equaled, and the output for 1916 will be still larger. It is a significant fact that, whereas in the past naval construction has constituted from 75 to 80 percent of the output of the yard, at the present time nearly 67 percent consists of merchant vessels, and all of these are for the American merchant marine.

Toledo Shipbuilding Company

That shipbuilding on the Great Lakes is no longer confined to the construction of lake vessels only, is shown by the fact that at the plant of the Toledo Shipbuilding Company, Toledo, Ohio, eleven vessels are under contract, six of which are for the Atlantic coast trade, four for Norwegian trade and one for the Great Lakes.

This plant is located on the Maumee river, six miles from Lake Erie, with a 23-foot channel to the coal and ore docks above the yard. The plant covers 20 acres and has three building berths and two dry docks. Two of the building berths are 550 feet long and one 650 feet long. One of the dry docks is 550 feet long by 100 feet wide, and the other 650 feet long by 100 feet wide with 16 feet of water over the sill. Gantry cranes of 10 tons capacity serve each of the building berths and extend 32 feet over each dry dock, running the full length of the dock.

The yard is complete with departments for building and repairing all types of vessels, machinery, boilers, auxiliary machinery, electrical machinery and lighting plants, steam fitting, piping, plumbing, rigging, joiner and carpenter work, etc. The yard has a capacity of producing about 25,000 gross tons of shipping per year and employs from 800 to 1,200 men.

The equipment of the yard includes a 100-ton shear leg located on the dock front for hoisting machinery, boilers, etc., and four 10-ton jib cranes located at the dry docks and slip. The slip is large enough to berth four vessels.

Vessels Built in the United States in January.—According to reports from the Bureau of Navigation, Department of Commerce, 48 vessels of 26,408 gross tons were built in the United States and officially numbered during the month of January. Six of these vessels of 21,373 gross tons were steel steamships. The largest vessel built during the month was the *Santa Barbara,* built by the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., for the Atlantic & Pacific Corporation.



Fig. 1.—Electric Tower Cranes at Harlan & Hollingworth Shipyard

The Harlan & Hollingsworth Corporation

Shipbuilding and Repair Yard that Forms an Important Subsidiary of the Bethlehem Steel Corporation

At the plant of the Harlan & Hollingsworth Corporation, located on the Christiana River, at Wilmington, Del., fourteen vessels of about 85,000 tons deadweight, valued at about $10,000,000 (£2,050,000), are under construction, furnishing employment to about 2,000 men. Never in the experience of the company have the prospects for shipbuilding been better. Their repair and drydock work is normal for the port, and there is every prospect of a continuation of inquiries for new construction.

The Harlan & Hollingsworth shipyard dates back to the pioneer days of iron and steel shipbuilding, having built in 1843 the first iron seagoing, single-screw steamship to be built in the United States. This was the *Bangor,* of 450 gross tons. Since that time over 450 vessels of various types have been built at the yard. Since 1905, when the plant, together with the Union Iron Works, of San Francisco, and the Bethlehem Steel Company, of South Bethlehem, Pa., became subsidiaries of the Bethlehem Steel Corporation, the yard has been entirely rebuilt and reorganized. The building ways were rebuilt, making in all five launching ways capable of accommodating vessels up to 520 feet in length.

In connection with the building slips, nine electrically operated tower cranes of 5 tons capacity, with a radius of 90 feet, were installed by the Terry & Tench Company, Inc., New York. In these cranes the main fall is in two parts and the boom fall is in seven parts. The drum speed of the hoist machines is 200 feet per minute. The drums are operated by a 75-horsepower, 220-volt, direct-current motor. Rotation is effected by means of a swinging gear driven by the main hoisting motor operating a pinion, engaging a fixed external gear attached to the top of the tower. The speed of rotation is about one complete circle in a little less than one minute.

Seven of these cranes were installed in 1914, while the remaining two have only recently been installed. The machinery design in the two cranes recently installed is somewhat different from that in the others. The two-drum hoist is operated by a direct-current motor, as in those already described, but rotation is effected by means of a 20-horsepower, direct-current motor independent of the hoisting motor, which drives through a pair of bevel gears a vertical shaft, on the lower end of which is a pinion, which engages the fixed gear already mentioned. This rotating gear is very powerful and quick, and

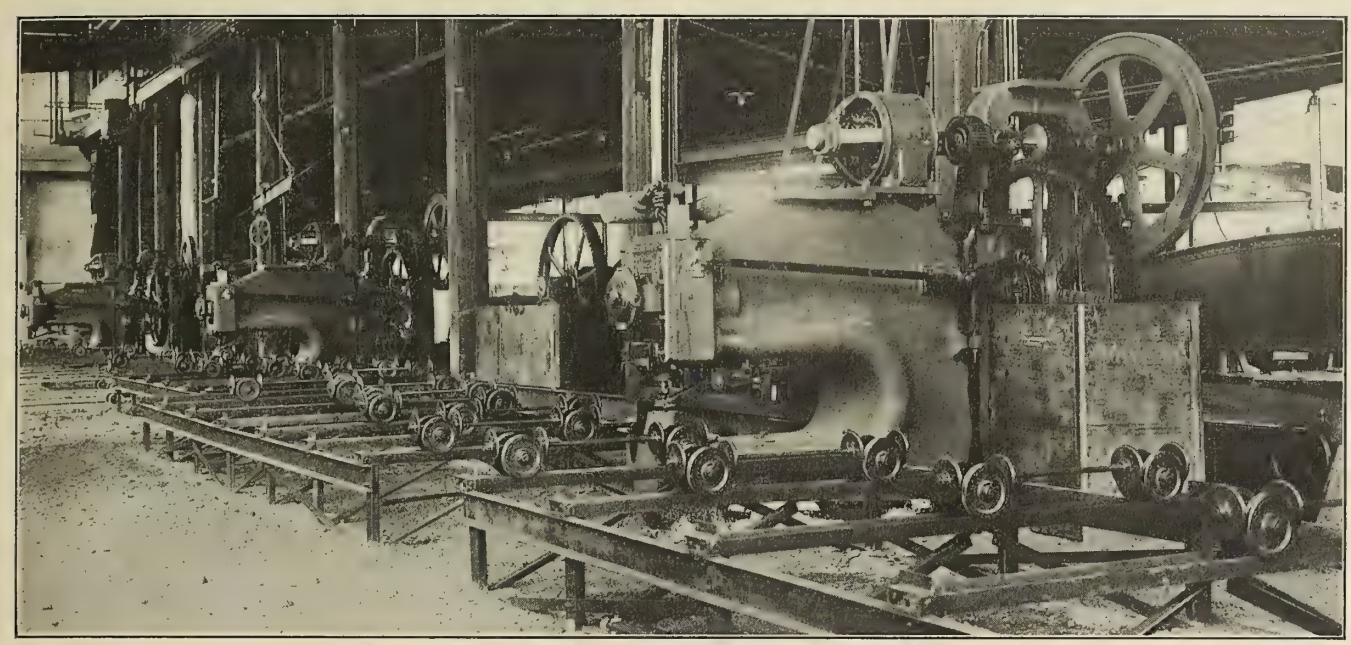


Fig. 2.—Section of the Plate Shed, Showing Punches

is a marked improvement over the first installation.

The hoisting platform is placed high enough to allow it to swing over the ships or their staging. This fixes the height of the tower which supports the mast. The cranes near the water have a tower 55 feet high. The towers amidships are 62 feet high, while those at the bow of the

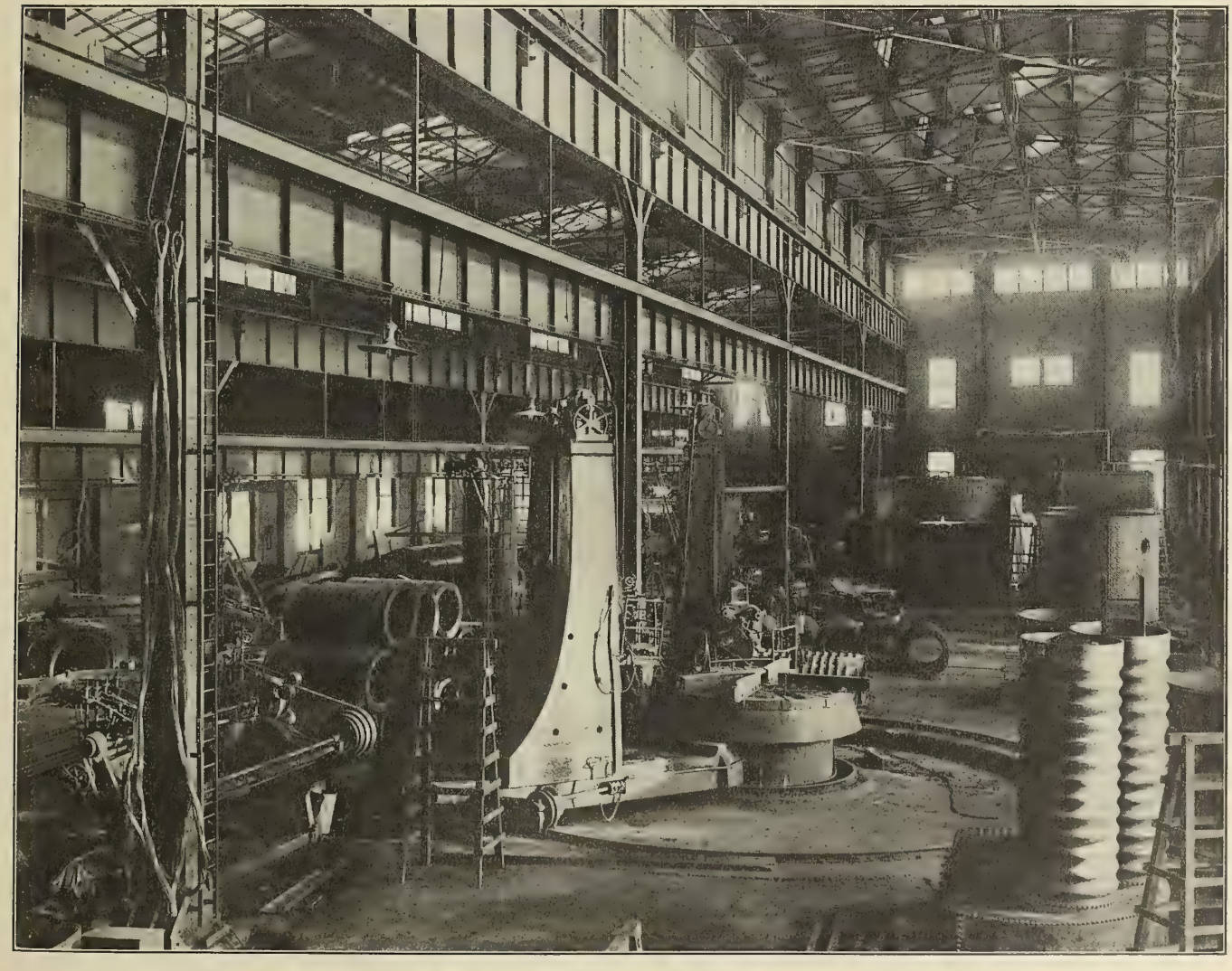


Fig. 3.—Interior of the Boiler Shop, Showing Special Shell Drilling Machine

ship extend up to a total height over all of 72 feet.

The yard is equpped with a basin dry dock large enough to dock vessels up to 345 feet in length, drawing 13 feet of water or less.

An important feature of the plant is a splendidly equipped boiler shop 300 feet long by 124 feet wide. The shop is equipped with electric traveling cranes, and all the machinery is electrically driven. The equipment includes several machines of special design built by the Bethlehem Steel Works, including both horizontal and vertical bending rolls and a boiler shell drill with three heads, each being equipped with four spindles.

Electric current for the entire plant is generated in a central power house by two Macintosh & Seymour cross compound, vertical, condensing engines, directly connected to General Electric generators. The main engines are used for day service, while for night service there is also a 15-kilowatt marine type generating set and a 150-horsepower Curtis turbine connected to two General Electric generators. Compressed air for the yard is furnished by Franklin air compressors, and pressure for the hydraulic machines and tools is furnished by a Worthington pump.

The output of the yard embraces every style of vessel from small pleasure launches to the largest and swiftest steam yachts, river and harbor steam and ferry boats, large passenger and freight ships for coastwise service, sound and bay passenger and freight steamers, such as the *Virginia, Manhattan* and *Narragansett,* coastwise lumber steamships, of which the *Columbia, John A. Hooper* and *Francis Hanify* are examples, as well as large ocean-going oil tank steamships, several of which are now under construction.

Morse Dry Dock & Repair Company

Plans have been completed and the preliminary work is well under way for practically the complete reconstruction of the large marine repair plant of the Morse Dry Dock & Repair Company, Brooklyn, N. Y. The entire plant covers 20 acres and extends 1,900 feet out into the harbor. The new buildings to be erected include a three-story and basement, steel and concrete office and storage building 240 feet long by 65 feet wide. It will contain on the ground floor a storeroom for ship fittings and supplies, including all kinds of marine brass goods, while the second floor will contain the general offices, and the third floor offices, luncheon rooms and other departments of the plant. It is also proposed to build a sectional wooden floating dry dock of 30,000 tons capacity capable of accommodating vessels up to 750 feet in length. The pumping equipment on the dock will be electrically driven, of sufficient capacity to lift the dock in twenty minutes.



The Morse Dry Dock & Repair Plant, as it Will Look When Improvements Are Completed

The present floating dry dock operated by the company has a capacity of 15,000 tons. This was built fifteen years ago and is one of the first docks of its type to be constructed. The old dock is equipped with electrically driven, centrifugal pumps, and can be lowered in 7 minutes and pumped up in 35 minutes.

The machine shop is 475 feet long and 85 feet wide, but will be enlarged by increasing its length 200 feet. A new boiler shop 200 feet by 80 feet will also be built, as well as a two-story carpenter and joiner shop 200 feet by 50 feet, and a coppersmith and plumbing shop 150 feet by 50 feet. An important part of the equipment of the plant is an oxy-acetylene plant supplied by the Superior Oxygen Company, Pittsburg. Gas torches are used for cutting metal, while an electric welding plant is available for welding.

The company's piers extend out into the harbor 1,500 feet and there is a depth of water alongside the piers of from 25 to 35 feet. Although the Bush Terminal Railroad runs by the plant, all material is lightered to the yard, as this method of transportation has been found cheaper than by rail.

Robins Dry Dock & Repair Plant

Equipment and Improvements at One of the Largest Ship Repair Plants in the United States

The plant of the Robins Dry Dock & Repair Company, located at Erie Basin, Brooklyn, N. Y., is one of the largest and most completely equipped yards for the exclusive repair of ships in the United States, if not in the world. The plant covers about 30 acres and has a water frontage of over 3,000 feet, which does not include pier measurements.

There are five large dry docks as follows:

No. 1—Graving, 510 feet long, 115 feet wide, 26 feet deep.
No. 2—Graving, 620 feet long, 111 feet wide, 30 feet deep.
No. 3—Sectional, 370 feet long, 110 feet wide, 12 feet deep.
No. 4—Sectional, 560 feet long, 127 feet wide, 17½ feet deep.
No. 5—Sectional, 370 feet long, 101 feet wide, 12 feet deep.

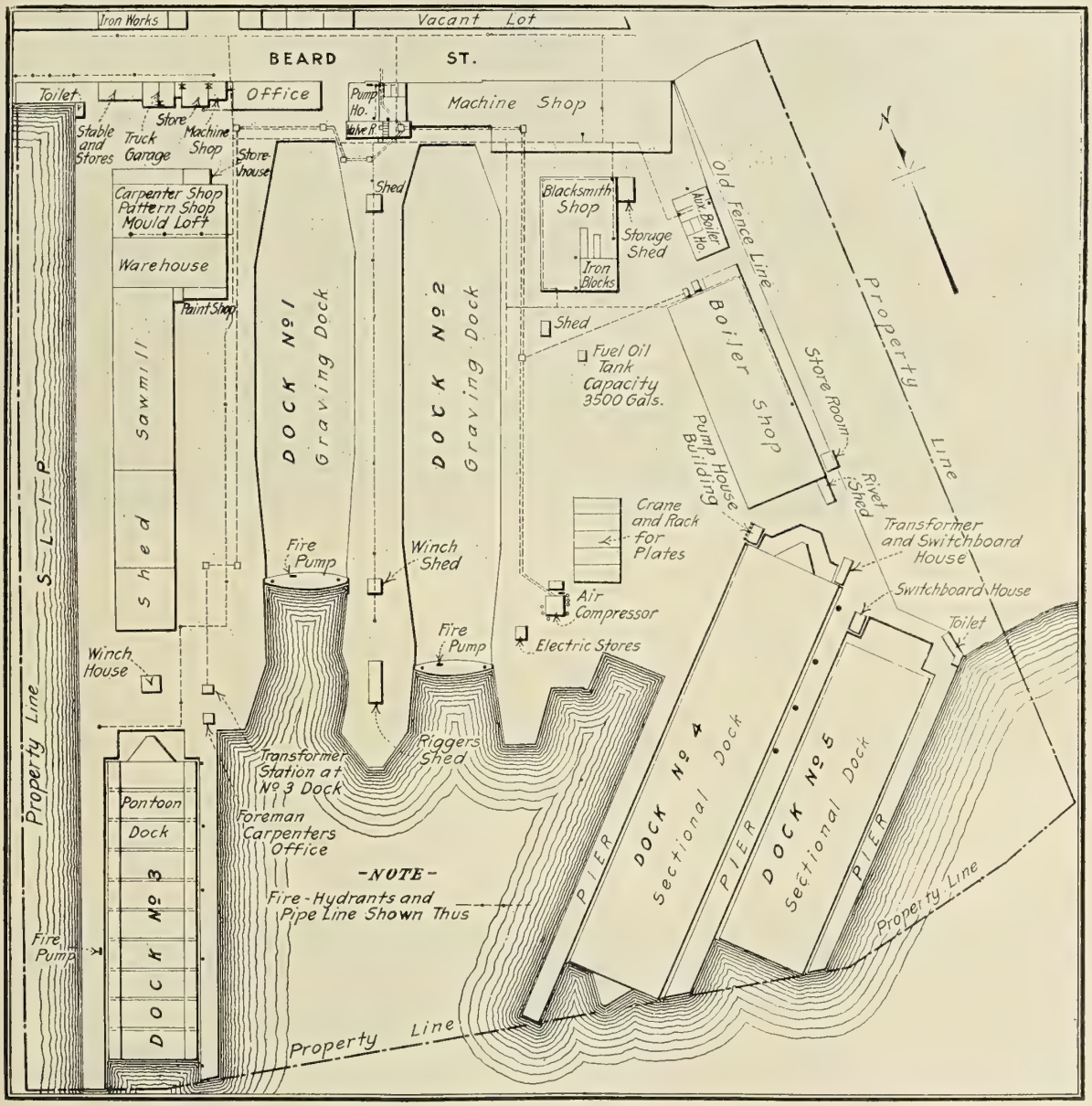


Fig. 1.—Plan of the Robins Dry Dock & Repair Plant at Erie Basin, Brooklyn, N. Y.

Plans are being prepared and options on the material have already been received for increasing the size of one of the graving docks to a length of 1,100 feet and a width of 110 feet with a depth of water over the sill of 32 feet.

Within the last seven years vast improvements have been made in this plant. The plant has been fitted through-



Fig. 2.—Cunard Liner *Carpathia* in Dry Dock No. 4 at the Robins Plant

out for electric drive, which includes the running of all shop tools by motors, as well as the new electrically driven centrifugal pumping system which drains the No. 1 and No. 2 graving docks.

Within this time there has been built a 6,000-ton steel wing floating dry dock, which has ten wood pontoons all arranged to disconnect from the wings if necessary. This dock is operated by two 300-horsepower motors, one on each wing, which drives the line shaft connected to pump shafting, each section having its independent pumps. This dock has been fully described in the August (1909) issue of Marine Engineering.

The new 24,000-ton floating dry dock, which has now been in operation for about two years, is 560 feet long, 127 feet wide, and 17 feet 6 inches depth of pontoons, the wings being 32 feet high above deck of pontoons. The dock is built in six sections, the end sections having 30-foot outriggers.

Owing to the disposition of the dry docks and piers before this dock was ordered, it was found necessary to rearrange the location of their present floating docks, as well as to make extensive changes, which involved a large amount of work. The 6,000-ton steel-winged pontoon dock was shifted to the opposite side of the yard, which required considerable dredging, the removal of one pier and the building of a new pier 21 feet wide, 384 feet long. The old 6,000-ton sectional dock had to be removed and entirely reconstructed by dispensing with the balance floats and upper structure and the building of new wings on sections, also the electrification of same. The 4,000-ton balanced dock was dispensed with, and besides the dredging for the new dry dock, which required nearly 50 feet of depth at low water, three long piers and a large pier platform were built, to which the new dock and the reconstructed dock are anchored.

Within the last year the company has built a large modern machine shop 310 feet long and 80 feet wide, with mezzanine floor. This new shop was built over the old one, and all changes to tools were made and the old shop demolished without losing a day's work. The new shop is built of steel on pile and concrete foundations, and the entire structure is constructed of steel framing concrete walls with large window area for light and ventilation. There are two 20-ton electrically operated traveling cranes installed, which operate the full length of shop, besides the industrial railway. New electrically driven machinery was installed of all types at an outlay of over $100,000 (£20,500), and all the old large tools were arranged with electric drive.

A new Ingersoll Rand air compressor of about 2,500 cubic feet capacity, electrically driven, was recently installed, also a new generator switchboard, etc.

The company is at present erecting a new blacksmith shop, which will also enclose the bending blocks, furnaces and flange fires. The building will be of concrete and steel construction and furnished with additional hammers,

forges, cranes, etc., to make it up to date in every respect.

New oil-burning plate and angle furnaces have recently been installed, and the company is now at work on the building of a modern brass foundry and galvanizing plant. The work of laying concrete paving throughout the entire yard is now under way, considerable of this work having already been completed and a complete industrial railway system has been built extending to all parts of the yard and shops.

Due to the removal of the old machine shop, which also contained the pipe shop, coppersmith and tinsmith shop, a new shop was erected to accommodate these departments with new machinery, tools, etc., complete, and the saw mill was enlarged by the addition of independent motor-driven tools.

In addition to the above shops, the facilities of the plant for making repairs consist of a boiler and plate shop, carpenter shop, joiner shop, pattern shop and mold loft. All the work on ships, such as chipping, calking, riveting, etc., is done with the use of pneumatic tools operated by an air compressor plant of three large electrically driven Ingersoll Rand machines. There is also a complete acetylene gas-burning outfit.

The floating equipment consists of a large twin-screw floating derrick, a steam launch, power launch, to which will be added in the near future a floating compressor plant and electric welding outfit.

Some of the jobs which have been completed at this yard are reconstruction of the American liner *New York,* the rebuilding of the steamers *Monteagle, Lansing, Chr. Knudsen, Massachusetts, Commonwealth, Plymouth, Jose, Antillian, Admiral Sebree, Admiral Clarke;* reboilering of the *Esperanza* and *Monterey* and the conversion of the steamer *Mills* from a freighter to a floating factory for the production of fish oil and fertilizer. The Clyde Line steamer *Iroquois* and the steamship *Howard,* of the Merchants' and Miners' Transportation Company, have been cut and each lengthened 40 feet, the latter job being a record for speed and workmanship for work of this class. A number of oil barges have also been lengthened, as well as the steamboat *New York,* of the Albany Day Line.

The following vessels were built at this yard: The steam yachts *Aloha, Felecia, Seminole, Hauoli* and *Marrietta,* a tug for the Clyde Steamship Company, and a number of steel whaleback barges; also the United States gunboat *Scorpion,* formerly the steamship *Sovereign,* and the steam yacht *Nokomis.*

Among the contracts which the company now has on hand are the steamships *L. V. Stoddard, George Hawley* and the steamship *Geo. E. Warren,* of the Boston Virginia Transportation Company, which will be lengtehened 52 feet, besides being converted into bulk oil carriers and arranged for the burning of oil fuel; the conversion of the steamships *Kroonland* and *Finland,* of the International Mercantile Marine Company to oil burners, and other repair jobs of all descriptions.

Ship Repair Yards in New York Harbor

Dry Docks Available for Vessels of Every Size and Description — A Thriving Industry at America's Greatest Port

On account of the large amount of shipping clearing from the port of New York, New York harbor has become the home of some of the largest and best equipped dry dock and repair plants in the world. Two of these, the Robins Dry Dock & Repair Company and the Morse Dry Dock & Repair Company, are described in the foregoing pages, while below are given the main particulars of the other leading repair plants in this harbor.

Work is carried on day and night at the busiest of these plants. Craft of every description are cared for and extensive equipment for both metal and wood working is required.

One of the largest repair yards in New York harbor is the Tietjen & Lang Dry Dock Company, Hoboken, N. J., which has nine dry docks capable of docking vessels from 500 to 10,000 tons. The capacities of the docks are as follows: No. 1, 500 tons; No. 2, 2,000 tons; No. 3, 800 tons; No. 4, 1,000 tons; No. 5, 1,800 tons; No. 6, 10,000 tons; No. 7, 1,000 tons; No. 8, 800 tons; No. 9, 5,000 tons.

The company employs 2,000 men and handles work valued at about $2,500,000 (£512,500) each year. The plant covers an area of 25 acres, and in addition to the nine dry docks has eight piers for mooring vessels. Its plate shop is one of the largest of the kind in New York harbor. In addition, there are a sawmill and joiner shop, a blacksmith shop, a machine shop, boiler shop and paint shop, besides a storage yard containing the largest stock of lumber of any repair plant in the harbor.

The repair plant of James Shewan & Sons, Inc., in South Brooklyn, N. Y., has seven dry docks. Six of them



Fig. 1.—Plate and Boiler Shop at the Plant of James Shewan & Sons, Inc.

are of wood of the following capacities: No. 1, 700 tons; No. 2, 2,800 tons; No. 3, 3,500 tons; No. 4, 2,500 tons; No. 5, 5,500 tons and No. 6, 6,600 tons. Dock No. 7 is a steel floating dry dock of 12,000 tons capacity, which was built in England and was formerly owned by the government.

The company handles repairs of any kind in wood, iron and steel, and they are able to take vessels at any tide and any time of the day or night. The company is exceptionally busy and does a large share of the repairing to ocean-going craft as well as coastwise and harbor craft. On account of the exceptional amount of business handled during the past year, extensive improvements have been made in the plant, costing about $100,000 (£20,500).

The Union Dry Dock & Repair Company, Weehawken, has a plant fully equipped for repairing wood and iron vessels. The equipment includes one large sectional dry dock and two smaller docks.

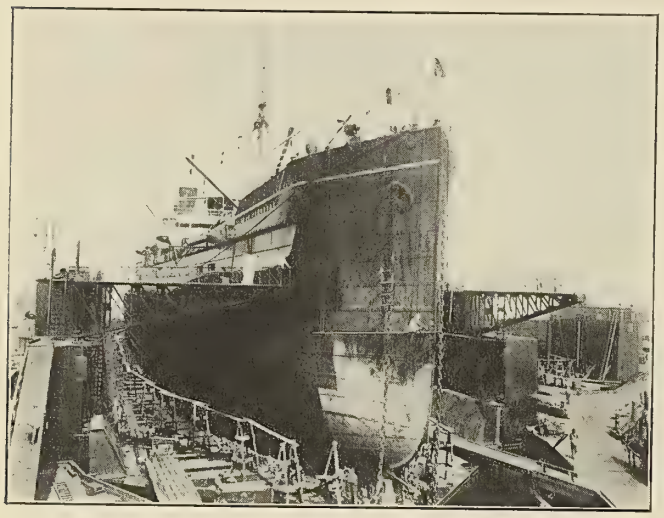


Fig. 2.—Dry Dock No. 7 at the Shewan Yard

The Grimes Engineering Company and Vulcan Iron Works, Inc., Jersey City, N. J., is not only equipped for ship repair work, having four dry docks, two of which are capable of handling vessels up to 2,000 tons, and two of 1,000 tons capacity, but also builds machinery and manufactures several marine specialties, including the Martin-Freeman compensating davit, and special dredging machinery. The shops are fully equipped for machine and blacksmith work. There is also a coppersmith and tinsmith shop and an extensive electric welding plant.

The Perth Amboy Dry Dock Company, Perth Amboy, N. J., shipwrights, calkers, machinists and boiler makers, has four balanced dry docks of 2,500, 2,000, 1,000 and 500 tons capacity, respectively, and a 25-ton derrick with ample pier room for mooring vessels for repairs. While most of the work at this yard is repair work, lighters or floats, barges and other harbor craft are built at the yard.

On Staten Island, aside from the shipbuilding and repair plant of the Staten Island Shipbuilding Company, which is described elsewhere in this issue, there are a number of shipbuilding and repair yards engaged principally in the building or repairing of wooden vessels.

The plant of Verdon & Co., West Brighton, Staten Island, is equipped with two floating docks of 1,600 and 800 tons respectively, where wooden vessels are repaired.

F. McWilliams Dry Dock Company has three floating docks capable of handling vessels from 600 to 2,000 tons. Although the yard is engaged principally in work on wooden vessels, it is gradually being equipped for work on steel vessels.

Three dry docks are available at the plant of Theodore Crane & Co. The capacities of the docks are: No. 1, 1,600 tons; No. 2, 5,400 tons, and No. 3, 9,000 tons. The plant is equipped for repairing both steel and wooden vessels and for building wooden harbor craft.

Three dry docks are also available at the plant of James Tregarthen & Sons Company of 1,000, 2,000 and 3,000 tons capacity, respectively, which are used only for work on the wooden hulls.

The Raritan Dry Dock Company, Raritan, N. J., builds and repairs wooden vessels and is also equipped for building boilers and engines. The docking facilities at this plant include three floating dry docks of 500 tons, 1,500 and 4,500 tons capacity, respectively.



Fig. 3.—One of the Machine Shops at the Shewan Plant

At the Brown Shipyard in Tottenville, Staten Island, two wooden vessels are in frame and one tug is nearing completion. At the Harry Cossey shipyard in Tottenville several wooden barges are under construction.

Manitowoc Shipbuilding & Dry Dock Company

The equipment of the Manitowoc Shipbuilding & Dry Dock Company, Manitowoc, Wis., is diversified to such an extent that the company can undertake a wide range of work. It has a completely equipped machine shop and carpenter shop, a building for laying out plans for complete vessels and for making templates by which steel plates are cut and punched, an electrical shop, pipe shop, tin shop and one of the largest and most completely equipped boiler shops in the Middle West. These facilities combined enable the Manitowoc company to design and construct steel passenger boats, steel freighters, sand suckers, dredges, lighters, fire boats, tugs, dump scows, marine engines, boilers, and other marine equipment.

This shipbuilding company now has under construction one steel survey vessel for the United States Government which will operate in Alaskan waters, a steel fire boat, the *Clevelander,* for the city of Cleveland, and three steel trawlers which are to operate on the Atlantic Coast. The Manitowoc yards are exceedingly busy on reconstruction and general repair work. For this class of work the yards are well equipped, as they have three dry docks, one of them being of steel construction and of sufficient size to accommodate lake freighters.

A short time ago the Manitowoc Shipbuilding & Dry Dock Company put up a large office building which is two stories high, and which is conveniently arranged and tastefully furnished. The lighting system throughout the office is of the indirect type. The buildings of this yard have been increased during the past few months by several extensive additions to the large plate shops and other equipment.

The American Shipbuilding Company

Facilities for Building or Repairing Ships at the Ten Plants Owned or Controlled by the American Shipbuilding Company

Owing to the unfavorable conditions prevailing in the shipping and shipbuilding industry on the Great Lakes during the past year, the American Shipbuilding Company, Cleveland, Ohio, which owns or controls no less than ten separate plants for building and repairing ships on the Great Lakes, and which has frequently ranked among the three or four largest producers of vessel tonnage in the world, experienced the lowest volume of business in its history in 1915. As present conditions indicate, however, the profitable employment of all bulk carriers on the Great Lakes during the coming season, and as there is a considerable influx of orders for ships for seagoing trade, there is every indication that the various yards of the American Shipbuilding Company will be profitably employed during 1916.

New Dry Dock at South Chicago

To meet the necessity of dry-dock facilities commensurate with the steadily increasing large tonnage trading at Lake Michigan ports, the company has constructed at South Chicago a dry dock 700 feet long and 103 feet wide, with a depth of water over the sill of 16 feet. The North Chicago plant of this company has been dismantled, the equipment being moved to the South Chicago plant. From the standpoint of the trade, the dispensing of this dry dock is more than compensated for by the additional dry dock and improved facilities at South Chicago.

The Chicago plant, which covers 23½ acres at 101st street and Calumet River, one mile from the harbor entrance, has three building berths, two 450 feet and one 600 feet long, and two dry docks, one a concrete dock 700 feet long over all, and the other a wooden dock 564 feet long over all. The equipment includes fully equipped punch and machine shops.

Cleveland Plants Centralized

For reasons of economy the company's Cleveland plants are being centralized on property adjoining the dry docks and shipyards at the foot of West Fifty-fourth street, where buildings for the general office and engineering department, the machine shop, foundry and pattern shop are under construction. The Cleveland plant covers 8 acres fronting 250 feet on Cuyahoga River bed, about one-half mile from the main river. There are two building berths aggregating 620 feet in length adjoining a fully equipped punch shop, and three dry docks of the following dimensions:

	Length Overall	Width at Gate
No. 1	552 feet	65 feet
No. 2	450 feet	48 feet
No. 3	350 feet	50 feet

The shops at this plant include a machine shop 100 feet by 120 feet, a foundry building 108 feet by 120 feet equipped with three cupolas, with a capacity of 18 tons per hour, and a complete brass foundry. There is also a pattern shop and pattern storage building 100 feet by 200 feet and a boiler shop.

At Lorain, Ohio, the company's plant covers 43 acres, located on the Black River, about one mile from the harbor entrance. There are four building berths accommodating vessels from 440 feet to 700 feet in length, and two dry docks 549 feet and 700 feet long, respectively. This plant has two fully equipped punch shops, a machine shop, 240 feet by 117 feet; a boiler shop 200 feet by 110 feet; a forge shop fully equipped for heavy forge work, and there is also an electric welder at the plant.

The Buffalo Dry Dock Company, Buffalo, N. Y., which is controlled by the American Shipbuilding Company, is at Ganson street and Buffalo River, and occupies 15 acres, about one and one-half miles from the entrance to the harbor. This yard has one building berth 402 feet long, three dry docks 625 feet by 65 feet, 432 feet by 52 feet, and 382 feet by 45 feet, and the necessary punch and machine shops.

Detroit and Wyandotte Plants

The Detroit Shipbuilding Company, also controlled by the American Shipbuilding Company, has two plants, one at Detroit and the other at Wyandotte, Mich. The Detroit plant occupies 12 acres at the foot of Orleans street, on the Detroit River, and is equipped with a dry dock 368 feet long and 92 feet wide, with 16 feet depth of water over the sill; a machine shop, brass shop and boiler shop.

There is also a foundry building 75 feet by 152 feet equipped with two cupolas, 7½ tons capacity per hour, and a complete brass foundry. The Wyandotte plant, also located on the Detroit River, covers 12½ acres and has two building berths 600 feet long, and punch and machine shops fully equipped.

At Milwaukee, Wis., there are two shipyards owned by the Milwaukee Dry Dock Company and controlled by the American Shipbuilding Company. The South yard, covering 8 acres at the foot of Mineral street, on the Kinnickinnick River, about one-quarter of a mile from the harbor entrance, is equipped with a punch and machine shop for repair work; a dry dock 450 feet long over all, 61 feet wide at the gate with a depth of water of 15 feet 6 inches over the sill, and a floating dock. The West yard, covering 4¼ acres, located on Canal street and the Menominee River, about one mile from the entrance to the harbor, has one dry dock 312 feet long over all, 45 feet wide at the gate, with 15 feet of water over the sill, and a machine shop fully equipped for wood repairs.

Extensive changes have been made at the American Shipbuilding Company's yard at Superior, Wis., which is known as the Superior Shipbuilding Company, whereby its several isolated units can be brought into close relation, permitting more efficient and economical operation of its dry dock and repair work without destroying its

ability to do construction work. The plant occupies 38 acres on Grand avenue and Second street and St. Louis Bay, about one-half mile from the entrance of the harbor. There are two building berths, accommodating vessels up to 600 feet in length, with a fully equipped punch shop and machine shop, and two dry docks. No. 1 dock is 591 feet long over all, with 14 feet of water over the sill, while No. 2 dock is 620 feet long, with 19 feet of water over the sill. A special feature of this plant is the self-propelled steamer *Robert J. Close,* equipped with electric and oxy-acetylene welding apparatus and other outfit capable of making repairs of every nature while vessels are discharging or receiving cargo in the harbor.

The remaining plant controlled by the American Shipbuilding Company is the Western Dry Dock & Shipbuilding Company, Ltd., Port Arthur, Ont., Canada. It comprises 100 acres, located on Current River Park and Thunder Bay, about one mile from Port Arthur and about four and one-half miles from the river mouth at Fort William. At this plant are two building berths, each capable of accommodating vessels up to 700 feet long, and one concrete dry dock 700 feet long, 98 feet wide and 16 feet deep. There are also a fully equipped machine shop, boiler shop, punch shop and foundry building, the latter being equipped with two cupolas of 15 tons capacity per hour.

The Johnson & Lanteri Shipbuilding and Repair Yard

Marine work of all kinds, including shipbuilding and repairs, and especially the construction and repairs of dredges, is carried out by the firm of Johnson & Lanteri, Pittsburg, California.

The company's plant is situated on New York slough, about one mile below the conflux of the San Joaquin and Sacramento Rivers, a location which is particularly adaptable for such work, as it is close to the Great Delta country, where dredges are extensively operated. Deep water is available, so that seagoing vessels can discharge lumber and materials on the company's wharf, making a minimum cost for transportation and, in addition, spur tracks from two trans-continental railroads lead into the yard.

This firm has built many of the largest clam-shell bucket dredgers in the world, some of them swinging 230-foot booms, a size of dredging apparatus which until recently has never been attempted. Although the firm specializes in dredge building and repairing, it also designs and builds boats and barges, and has built some highly successful gasoline (petrol) tow boats for service in and about the bay regions.

A marine ways, suitable for hauling out boats and barges of 100 tons displacement, forms part of the yard's equipment, and the building of a marine railway of 2,500 tons capacity is now contemplated. While wood has been the principal building material used at the yard in the past, the firm is now entering upon the construction of steel vessels, having recently turned out two steel dredger hulls for reclamation work. A set of shear legs, 105 feet high and capable of lifting 80 tons, with a spur track running under them, is located at the end of the company's wharf, which enables the firm to handle boilers and heavy machinery direct from cars to vessels.

Hanlon Dry Dock & Shipbuilding Company, Inc.

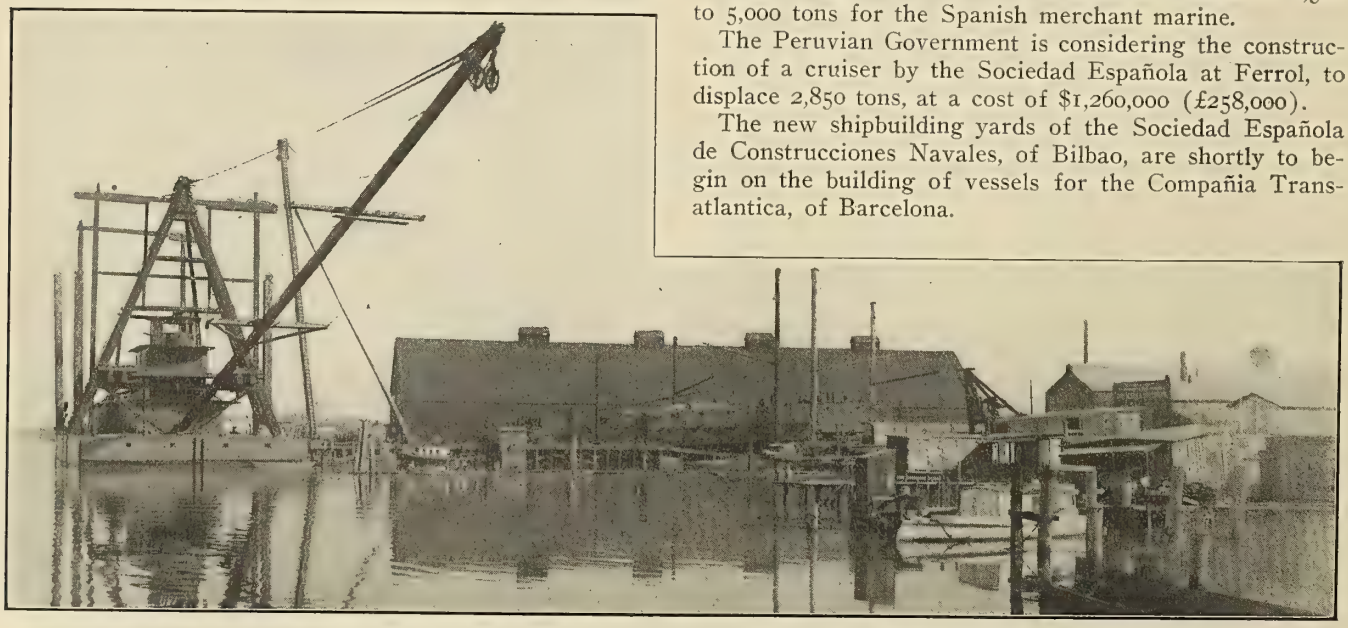
The Hanlon Dry Dock & Shipbuilding Company, Inc., Oakland, Cal., has taken over the business formerly conducted by Mr. D. J. Hanlon, and has built a modern electrically driven marine railway capable of handling a vessel of 4,000 tons, and a smaller marine railway capable of handling a vessel of 1,000 tons at light draft. Among the equipment installed is a machine shop equipped with the most modern motor-driven tools suitable for handling any kind of engine repairs. There is also a complete outfit of wood-working machines and air tools, and from one of the company's wharves now completed, with 35 feet of water alongside, water and electric light can be furnished. With the best submarine diving apparatus obtainable, the company is now in a position to handle any kind of repair work in marine practice.

Shipbuilding Activity in Spain

The shipbuilding yards of Nervion, Spain, are being enlarged to permit of the construction of vessels of 1,500 to 5,000 tons for the Spanish merchant marine.

The Peruvian Government is considering the construction of a cruiser by the Sociedad Española at Ferrol, to displace 2,850 tons, at a cost of $1,260,000 (£258,000).

The new shipbuilding yards of the Sociedad Española de Construcciones Navales, of Bilbao, are shortly to begin on the building of vessels for the Compañia Transatlantica, of Barcelona.



Waterfront of Johnson & Lanteri Plant, Showing Large Clam Shell Bucket Dredger Built by the Company



Fig. 1.—Seattle's Largest Shipyard is Located at the Busiest Part of the City's Commercial Waterfront

Seattle Construction & Dry Dock Company

Modern, Fully Equipped Shipyard in Seattle Now Building Five Large Freighters for the Atlantic Coast

The plant of the Seattle Construction & Dry Dock Company, covering approximately 30 acres, is situated in the busiest part of the commercial waterfront of the City of Seattle. Five transcontinental railroads, the Oregon-Washington Railroad and Navigation Company, the Northern Pacific, Great Northern, Chicago, Milwaukee & Puget Sound, and the Canadian Pacific serve the yard directly. The broad and open fairway of Puget Sound, deep and absolutely unobstructed by bar, reef or shallow, may be followed right up to the company's docks.

The plant is modern in every respect and is equipped for a great range and variety of construction and repair work. The equipment consists mainly of two floating dry docks of 12,000 and 3,000 tons lifting capacity, nine building berths for vessels from 150 to 600 feet in length, a saw mill, planer mill, and sheer legs of 60 and 75 tons capacity. There are four piers ranging from 300 to 750 feet in length for the accommodation of vessels undergoing repairs and receiving equipment.

The shops include a machine shop, pattern shop, foun-

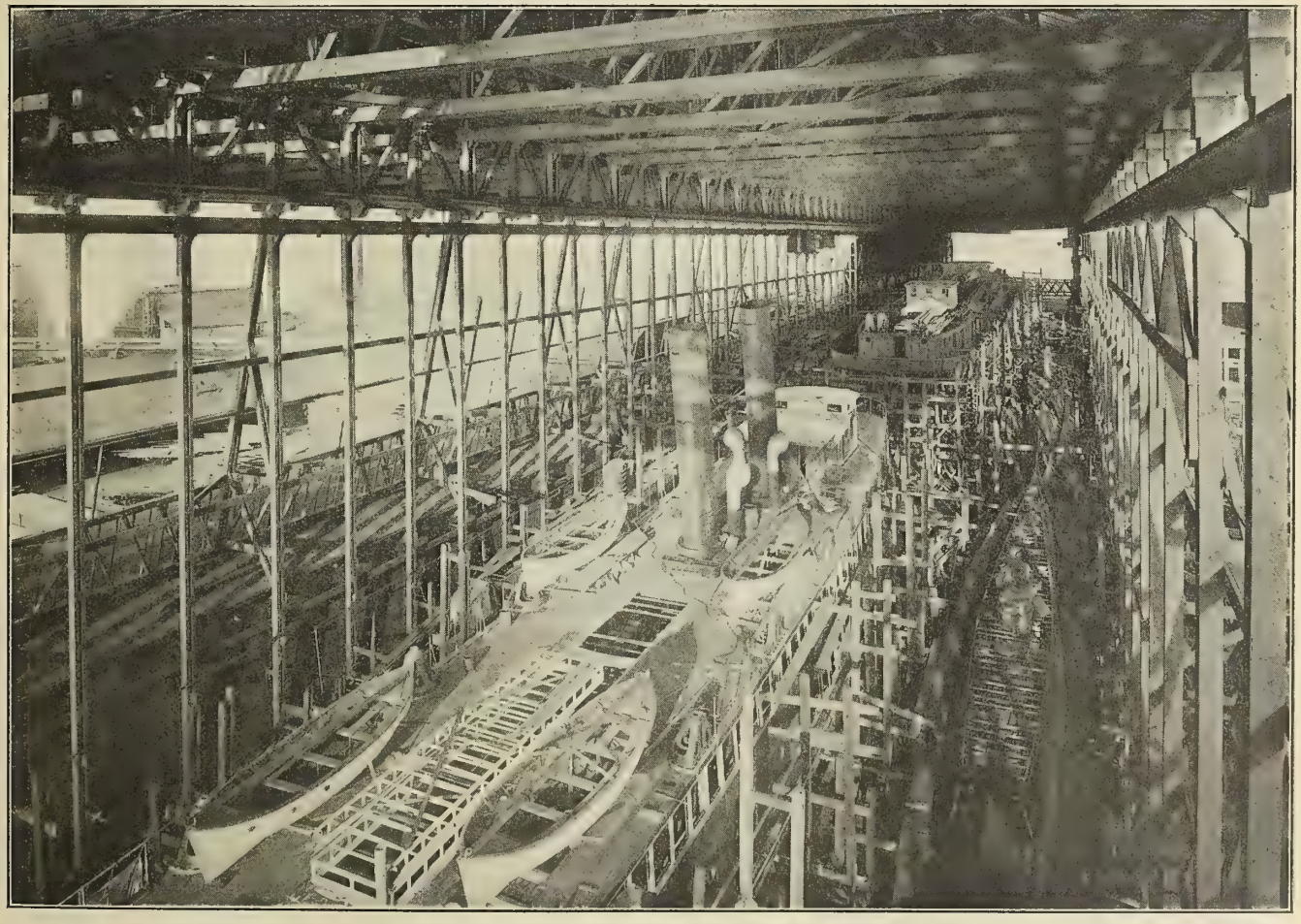


Fig. 2.—Interior of Steel Sheds with Vessels Under Construction

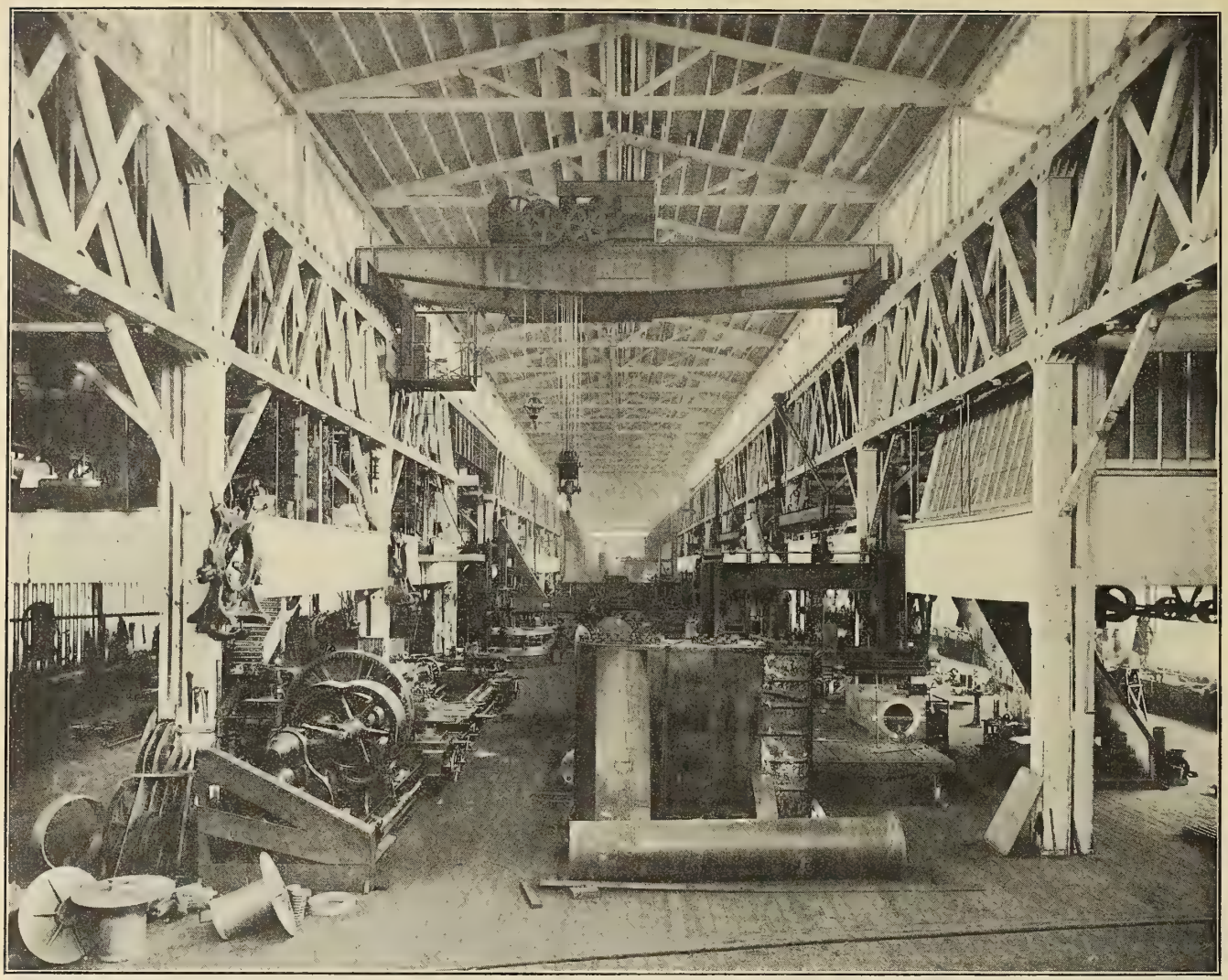


Fig. 3.—Partial View of Machine Shop at Seattle Construction & Dry Dock Plant

dry, joiner shop, carpenter shop, boiler shop, blacksmith and forge shop, bolt shop, pipe shop, galvanizing shop, steel construction shop, mold lofts and power plant of capacities to handle the work required in the construction of ships and in making repairs.

The plant is equipped to handle merchant vessels of all types and also government vessels, now having under construction and contract five freight ships for the Atlantic coast, three submarine torpedo boats and one torpedo boat destroyer, approximating $5,500,000 (£1,125,000) in value.

A large amount of repair work is being carried on on coastwise vessels, and foreign vessels making the Port of Seattle from time to time along with the new construction work.

Increased facilities for handling more tonnage are under consideration, but the details are not yet ready for publication. It is expected, however, that after the improvements are completed the company will be able to handle much more work.

Hannevig Motor-Driven Oil Tankers

Four large motor-driven oil tankers, designed by Cox & Stevens, naval architects, New York, for Cristoffer Hannevig, Christiania, Norway, are now under construction by the Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md. As soon as these vessels are launched three additional vessels of the same size and type, but to be equipped with single-screw geared turbine-propelling machinery, will be laid down, making in all seven large bulk oil carriers for the Norwegian trade.

These vessels are seagoing tank ships, 306 feet long over all, 47 feet beam, 28 feet depth of hold, with a load draft of 22 feet. The oil cargo will be carried in thirteen separate tanks formed by the shell of the vessel and divisional bulkheads, the total tank capacity being 4,500 gallons. Wing tanks provide space for extra cargo when weather conditions will permit deeper loading of the vessels. There are also trimming tanks forward and aft.

The first four vessels will be triple-screw ships, the motive power for each vessel consisting of three four-cylinder Bolinders oil engines of 600 brake-horsepower each. Fuel oil for these motors will be carried in a tank compartment adjacent to the engine room, with a capacity of 500 tons of heavy oil. Geared turbine propelling machinery supplied with steam by oil-fired Scotch boilers, will be substituted for the oil engines in the last three vessels, in order to secure a comparison of the results when using each type of power.

The question of auxiliaries has been carefully worked out, also the piping arrangements for handling and heating the oil, as well as the equipment for navigating and operating the vessels, so that the expense of operation will be reduced to a minimum without in any way sacrificing the efficiency of loading and transporting the cargo.

Record Year for the Union Iron Works Co.

San Francisco Shipyard, a Subsidiary of the Bethlehem Steel Corporation, Building Nineteen Vessels Aggregating 179,078 Tons

With nineteen large steamships, aggregating 179,078 tons, under construction, the Union Iron Works Company, San Francisco, Cal., is entering upon the most active year in its history. This company entered the steel shipbuilding field in 1882 and since that time has built 120 vessels of various types, including both naval and merchant ships, and the company's plant has been developed into the largest establishment for the building and repairing of ships on the Pacific coast.

The main works are at the Potrero on San Francisco Bay, about two miles from the city, covering 38 acres, while at Hunter's Point, about 1½ miles from the Potrero works, the company owns property covering 45½ acres where there are two graving docks, 750 feet and 483 feet long respectively, and where a new graving dock 1,096 feet long by 120 feet wide, with a depth of water of 40 feet over the sill, capable of docking the largest vessel that can pass through the locks of the Panama Canal, is to be built.

The main works at the Potrero are divided into two parts, the North Works and the South Works. The North Works contains seven building slips, two floating dry docks, numerous mooring berths, a set of 120-ton shear legs and the extensive shops which go to make up the complete plant with the exception of the pattern shop, brass and iron foundries, machine shop, erecting shop and bolt and rivet shop, which are located at the South Works.

The Union Iron Works Company became a subsidiary of the Bethlehem Steel Corporation in 1905, and since that time extensive improvements have been made, including the complete electrification of the plant, the construction of a new punch shop, blacksmith shop, saw mill and joiner shop, rigging loft, pipe fitters' shop, coppersmith shop, sheet iron shop, marine machinists' shop, marine electrical shop, four new building slips, a new brass foundry and the rearrangement of the storage yard and crane and conveying facilities. The new shops are of modern steel, concrete and brick construction elaborately equipped with complete systems of overhead traveling cranes and the necessary facilities for handling unfinished and fabricated materials.

In replacing four of the old wooden building slips, which were of wood wharf construction with wood overhead framing for the traveling cranes, the new slips were planned so that the weight of the ships will be carried on the original piles with new caps and stringers where required, and made flush with the surface with rock filling between and below in place of the old wood wharf surface. The wood overhead framing for the traveling cranes has been discarded for steel viaducts about 60 feet high running the full length of the slips. Each viaduct is designed to carry a 30-ton electric locomotive crane traveling on a 10-foot gage track with booms reaching 10 feet beyond the centerline of the vessels on the ways.

Although the plant has a water frontage over a mile long, it has recently been reported that the company has bought the plant of the United Engineering Works in San Francisco, in order to furnish additional facilities for building steel hulls and engines.

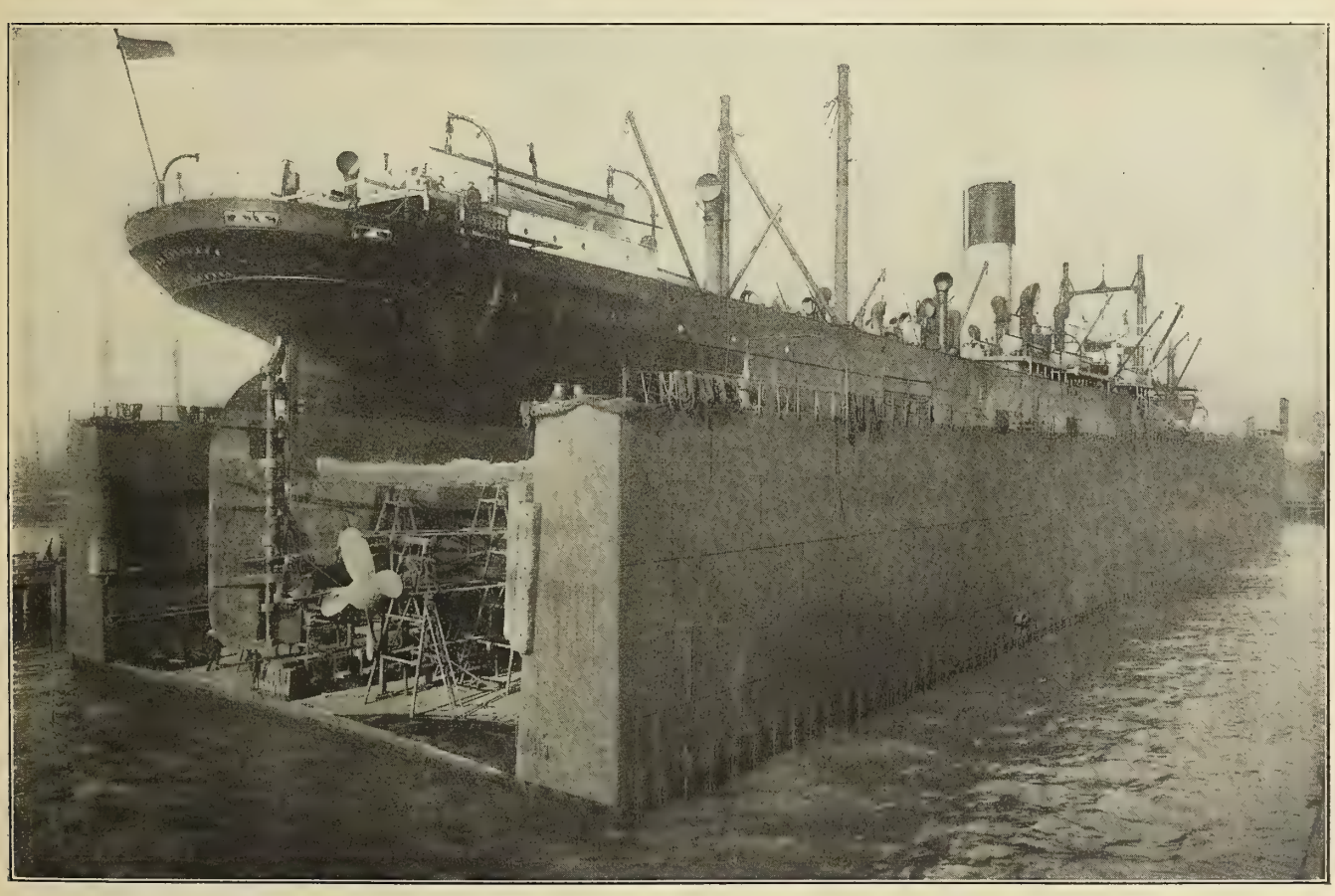


Fig. 4.—Steamship *Protesilaus* of 9,547 Tons in Floating Dry Dock of Seattle Construction & Dry Dock Company



Fig. 1.—Plant of the California Shipbuilding Company

California Shipbuilding Company

Plant for Building Lake Submarines on the Pacific Coast —Docking and Building Facilities for Merchant Vessels

The California Shipbuilding Company, the only steel shipbuilding, repairing and docking plant in Southern California, is at Long Beach, on San Pedro Bay, adjacent to San Pedro, the port of Los Angeles. It is about one hundred miles north of the Mexican border and four hundred miles south of San Francisco. In addition, there are thousands of miles of the coast line of West Mexico and Central America lacking entirely the service and equipment afforded by this company.

The yard was established in 1906 by the Craig Shipbuilding Company, and was sold on January 1, 1916, to the California Shipbuilding Company, which has the exclusive rights on the Pacific Coast to build submarine boats under the patents of the Lake Torpedo Boat Company, of Bridgeport, Conn. The intention of the company is to specialize, so far as construction work is concerned, in submarine boats. At the same time it is prepared to construct other types of Government and merchant vessels.

The layout of the yard in relation to the harbor readily adapts itself to the side-launching method, and the long front is, therefore, fitted with building berths on that principle. Two large overhead cranes travel the entire length over the berths and form in conjunction with a large number of spur railroad tracks, minor swinging and traveling cranes, and a narrow-gage push-car system, an economical and rapid scheme for handling material. A large new office building and various smaller buildings, such as storehouses, will be erected, besides other improvements; a new fitting-out wharf, with heavy sheer-legs, yard locomotive crane, electric charging plant for storage batteries, and extensive additions and improvements to the tools. The arrangement of the yard is such that, if necessary, several vessels could be built and launched endwise, in addition to the large frontage on which the side launching method is used.



Fig. 2.—3,500-Ton Dry Dock at the California Shipbuilding Plant

Considering the amount of repair and docking work done by the company, the large floating dry dock is one of the most important features. Designed by Wm. T. Donnelly, consulting engineer, New York, it represents the latest practice, and can handle 3,500 tons deadweight. The design is such that when the business afforded warrants it the dock can be greatly enlarged by merely adding additional units to the length. It is self-docking, as any portion can be detached readily, should repairs be necessary, and lifted by the intact portion. The dock is quickly operated by electrically driven pumps.

Electricity furnishes practically all the power required throughout the plant, and oil fuel is used entirely. The Union Oil Company's pipe line runs into the yard, and the Standard Oil Company also has a service station adjacent.

One of the best assets of the California Shipbuilding Company is the splendid climate of Long Beach, where ship construction and repairing can be carried on without the vexatious layoffs for frequent rains, snow and cold weather that so often embarrass most American ship yards. There is no snow at all, and rains only in the short winter season.

The work under way at present consists of the following: Submarines *L*-6, *L*-7, *O*-14, *O*-15 and *O*-16, and the lighthouse tender *Cedar*. The value of contracts for new construction is over $3,000,000 (£615,000). The plant is well equipped at present to handle, in addition to the foregong, two merchant vessels not exceeding 400 feet in length.

The company aims to enlarge the shipyard and increase the number of men. In war to-day a nation's fate hangs largely upon its practical force of engineers and skilled workmen. The company's purpose is sincere cooperation in the nation's preparedness policy, and the Government may have first call upon the company's men and shipyard.



Fig. 1.—Partial View of Waterfront at Hall Brothers Shipyard

Hall Bros. Shipbuilding and Repair Plant

Puget Sound Yard Noted for the Beauty and Seaworthiness of the Wooden Sailing Vessels Built

With the growth and development of the wood shipbuilding industry on the Pacific coast, the firm of Hall Brothers, and their successors, the Hall Brothers Marine Railway & Shipbuilding Company, Eagle Harbor, Winslow, Wash., has been closely identified. The firm was organized in San Francisco, Cal., in 1872, by the Hall brothers, who were experienced builders of the famous Gloucester type of fishing vessels on the Atlantic coast, and the shipyard was established at Port Ludlow, Wash. In 1882 the plant was moved to Port Blakeley, and in 1902 to its present site in Eagle Harbor, where there is a water frontage of half a mile and ample facilities for building and repairing wooden craft as well as for manufacturing ship's spars.

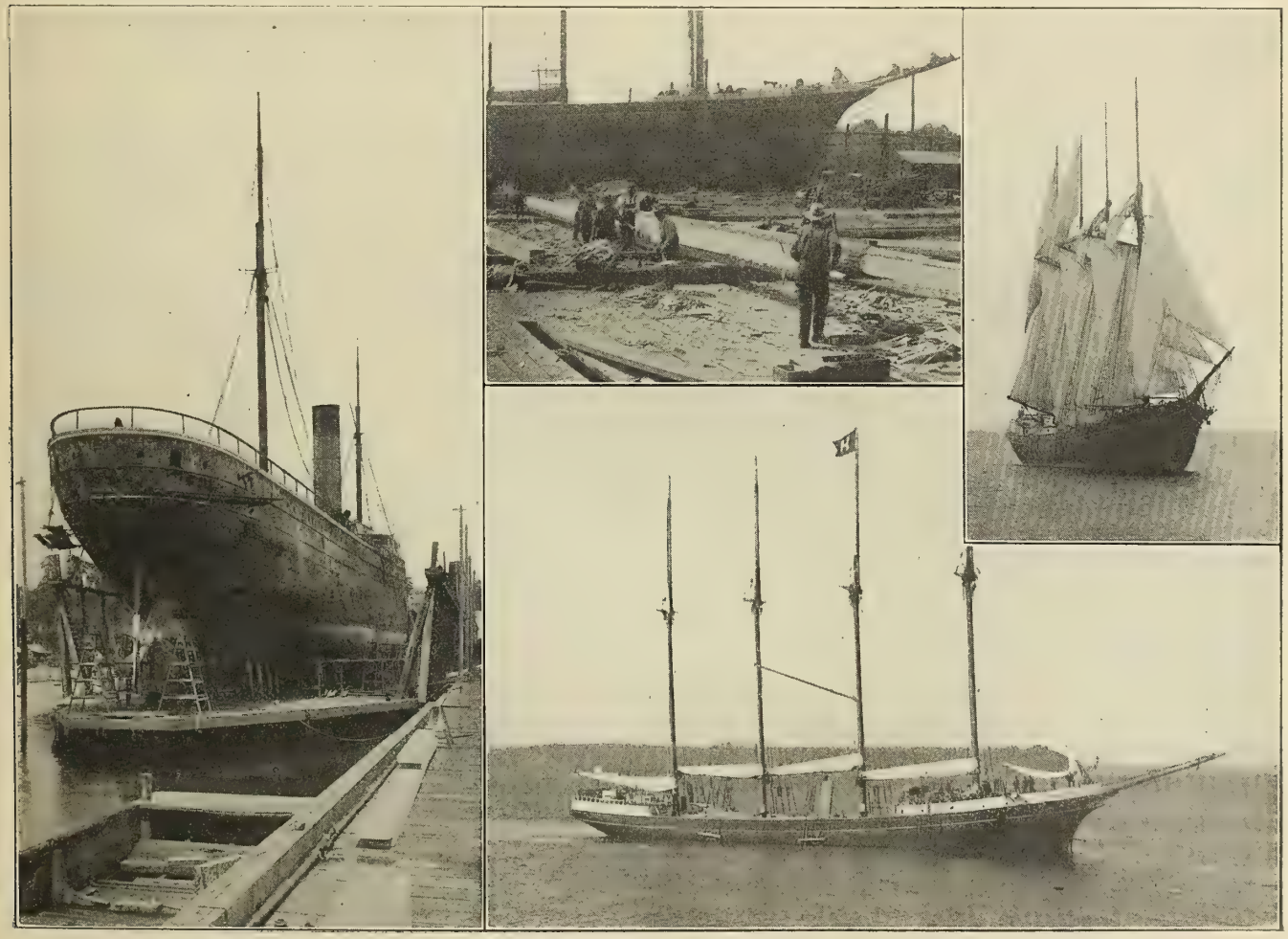


Fig. 2.—Character of the Work Handled by the Hall Brothers Marine Railway & Shipbuilding Company

During its existence the firm has built a total of 140 vessels, mostly wooden sailing vessels for the lumber trade, although in recent years, with the advent of the steam lumber schooner, there has been a gradual change to steel construction for this trade. While the Hall shipyard is not equipped for steel construction, it has nevertheless produced a number of wooden steam schooners, the size of which is limited to 250 feet in length, which the company considers the maximum size practicable for a wooden ship of the single deck type.

The yard is equipped with tools for hull repairs, tail shaft work, engine repairs and any character of iron work in connection with the wooden sailing vessels or small steamers plying Puget Sound or in the coasting trade. The yard has building slips capable of accommodating six vessels at one time. Three of the slips are covered and permit work being carried on during any kind of weather. In addition there are two railway dry docks, one of which, of the Crandall type, with a steel cradle 325 feet long, is capable of hauling vessels up to 4,000 tons deadweight. The other dock, with a cradle 136 feet long and a capacity of 400 tons deadweight, is arranged with a long haul inshore, provided with skids for side-tracking vessels for winter storage. Both the building slips and the marine railways are piped for air and a complete complement of air tools for use in repair or construction work is available. Compressed air is supplied by two Ingersoll-Rand compressors with a capacity of 750 cubic feet of air per minute.

The shops in the yard consist of a forge shop, boiler shop, machine shop and a combined sawmill and joiner shop, together with a mold loft.

An important part of the company's business is the installation of ship's spars, as the Oregon pine, or Douglas fir timber, as grown in the Puget Sound district, provides the best spars obtainable in any part of the world for ships.

The company is famous not only for the number of wooden sailing vessels which it has built, but also for the exceptional beauty and seaworthiness of the vessels which they have designed, which have included some of the largest and most successfnl sailing vessels built on the Pacific coast.

Inclined Elevators Increase Economy of Handling Freight at New York Central Weehawken Piers

At the Weehawken, N. J., piers of the New York Central Railroad Company, where inclined elevators, manufactured by the Otis Elevator Company, New York, have been installed for moving freight up the inclined gangways connecting the piers to vessels alongside, savings amounting to 3 cents per ton have been made over what it would have cost to handle the freight at these piers by hand. During the year 1915, 105,508 tons of freight were handled by the inclined elevators, and it is roughly estimated, after deducting interest, maintenance, depreciation and the cost of power, that the above saving resulted.

As to the effect which the elevators have had upon the length of time in handling the freight and in preventing congestion in the movement of the freight, conditions in New York harbor have undergone such a transformation within the past year that no comparisons can be made. There is no doubt, however, that these machines make it possible to unload lighters at the piers more quickly than it could be done without the elevators. This saving of time varies from 20 to 40 percent, and depends upon the tide, the character of the freight and the conditions on the floor to which the freight is being transferred, whether open or congested.

Willamette Iron and Steel Works

Since 1900 the Willamette Iron & Steel Works, Portland, Ore., which was formerly engaged in machinery and foundry work, has become an important shipbuilding and repair yard. Its plant, which covers five acres on the water front of the city and employs four hundred men, is divided into several departments, including, in addition to the shipyard, a logging and hoisting engine department and a plate department. Adjoining the shipyard is the plant of the Oregon Dry Dock Company, which enables efficient and economical ship repair work of all kinds to be carried out.

The boiler shop of the Willamette Iron & Steel Works is equipped with modern machinery for handling all classes of plate work up to 1⅛ inches thickness, and this equipment has enabled the company to carry out some of the most important plate work on the Pacific coast, including pen stocks and other work besides boiler work.

As this is the only shipbuilding plant in Portland where steel vessels are built, many of the vessels now employed on the Columbia and Willamette rivers have been built by this company. Their output has also included barges, dredges, tugs and passenger and work boats.

J. F. Duthie and Company

Although a comparatively newcomer among the Pacific coast shipbuilders, the firm of J. F. Duthie & Co., which has been in operation in Seattle, Wash., for about three years, has built four steel and one wooden vessel. The company's plant is equipped to handle vessels up to 200 feet in length, and, besides ship work, specializes in the construction of winches, windlasses and hoists. The vessels built by the firm include two steam whalers, a fishing steamer, a steam ferryboat and a cannery tender.

CORRECTION.—In the formula $V^3/\text{I. H. P.} = 436.16$, printed near the top of the second column on page 60 of our February issue, the factor "immersed midship section" was omitted. The formula should read:

$$\frac{\text{Immersed Midship Section} \times V^3}{\text{I. H. P.}} = 436.16.$$

On page 82 of the same issue, near the top of the second column, the equation $210 \times 32 = 178$ B. T. U., should read $210 - 32 = 178$ B. T. U., and the equation

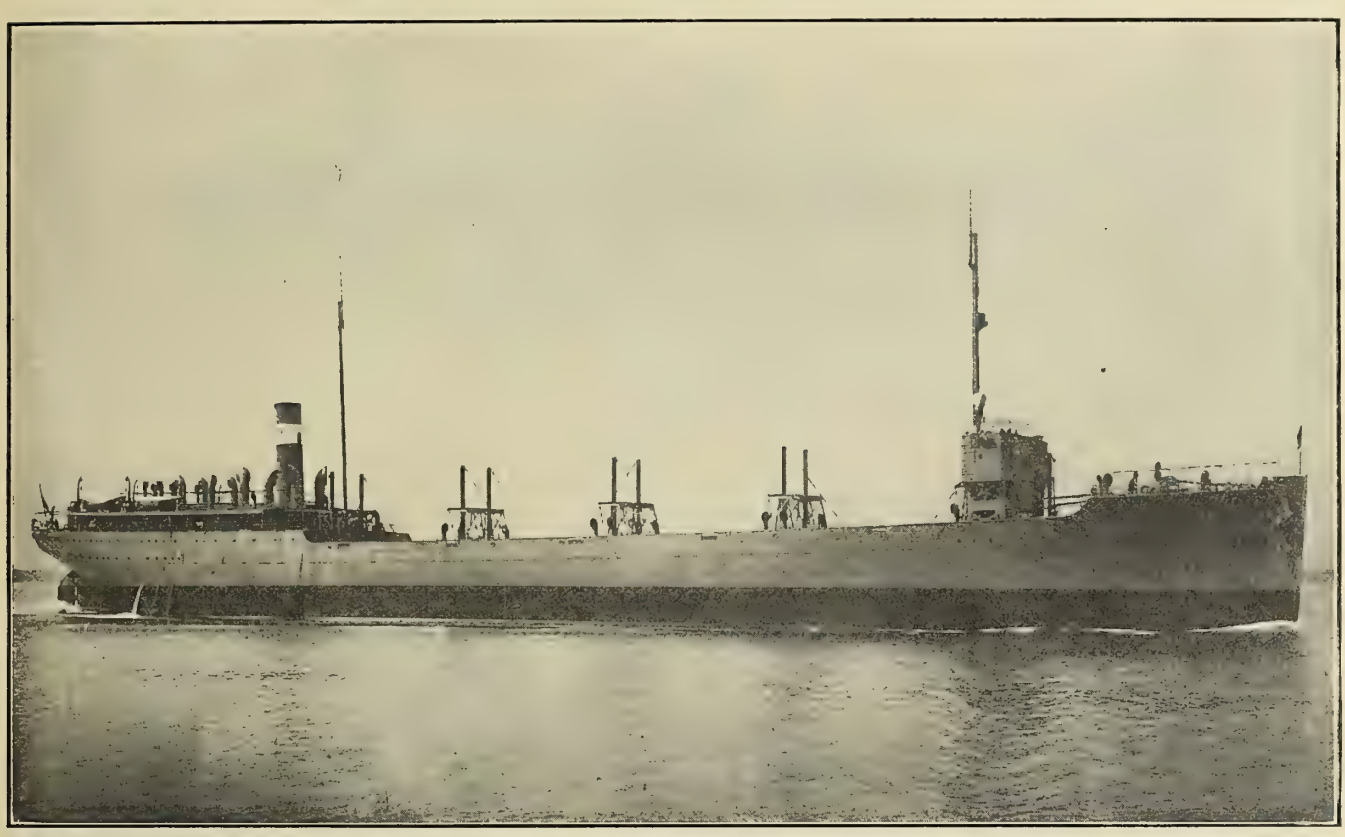
$$\frac{990{,}000 \times 60}{778} = 2{,}545 \text{ B. T. U. per hour}$$

should read

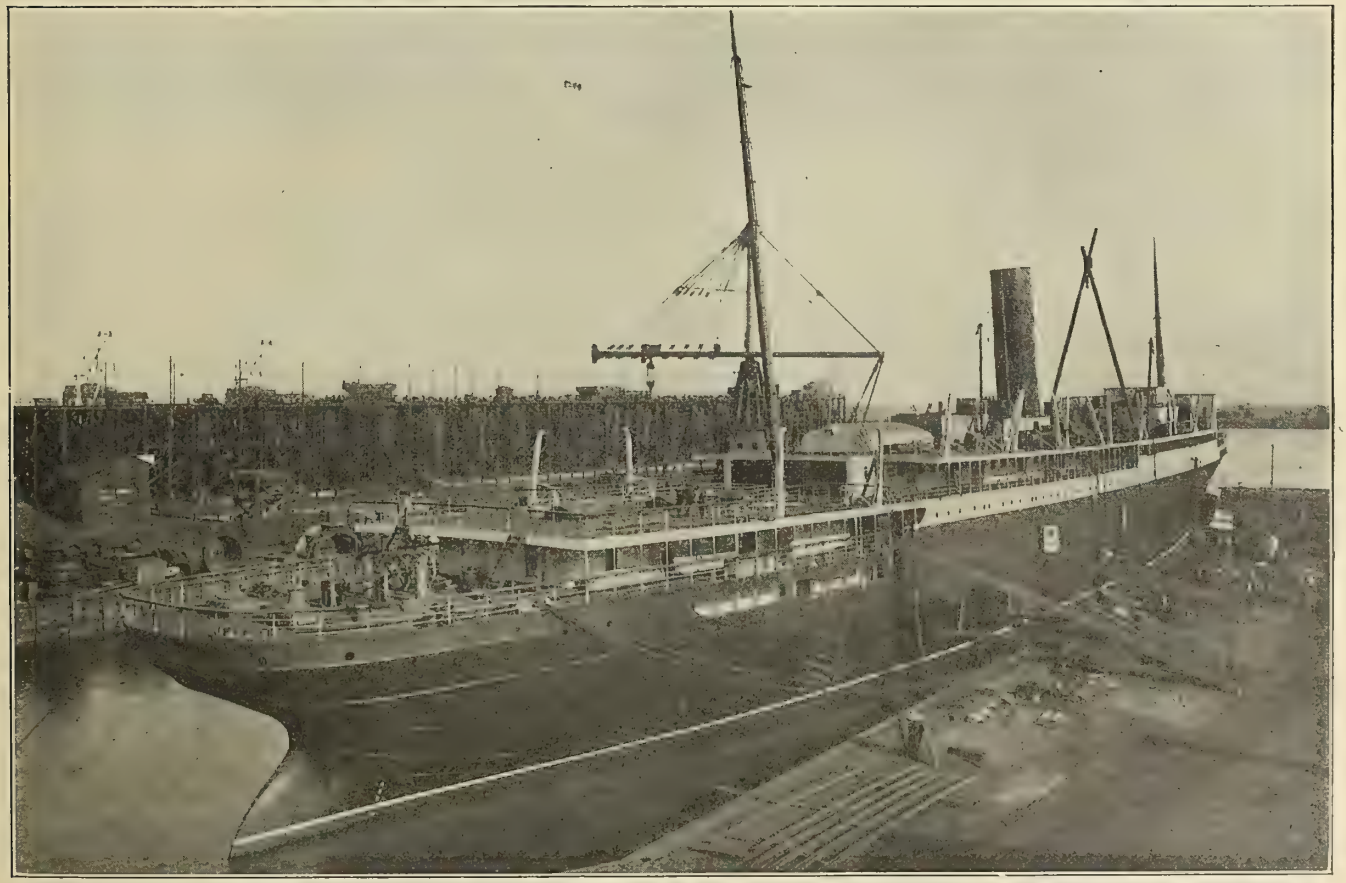
$$\frac{33{,}000 \times 60}{778} = 2{,}545 \text{ B. T. U. per hour.}$$

LLOYD'S QUARTERLY RETURNS.—The returns compiled by Lloyd's Register of Shipping, which take into account only vessels of 100 tons and upwards the construction of which has actually begun, show that, excluding warships, there were 420 vessels of 1,363,590 gross tons under construction in the United Kingdom at the close of the last quarter. The tonnage now under construction in the United Kingdom is about 173,000 tons less than that which was in hand at the end of the previous quarter, and about 264,000 tons less than that building a year ago.

Types of Ships Built in American Yards



Panama Collier *Achilles*, Built by the Maryland Steel Company, Sparrows Point, Md.



23-Knot Turbine Passenger Steamer *Great Northern*, Built by Wm. Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa.



Coastwise Collier *Jonancy*, Built by the New York Shipbuilding Company, Camden, N. J., for the Pocahontas Navigation Company, Boston, Mass.



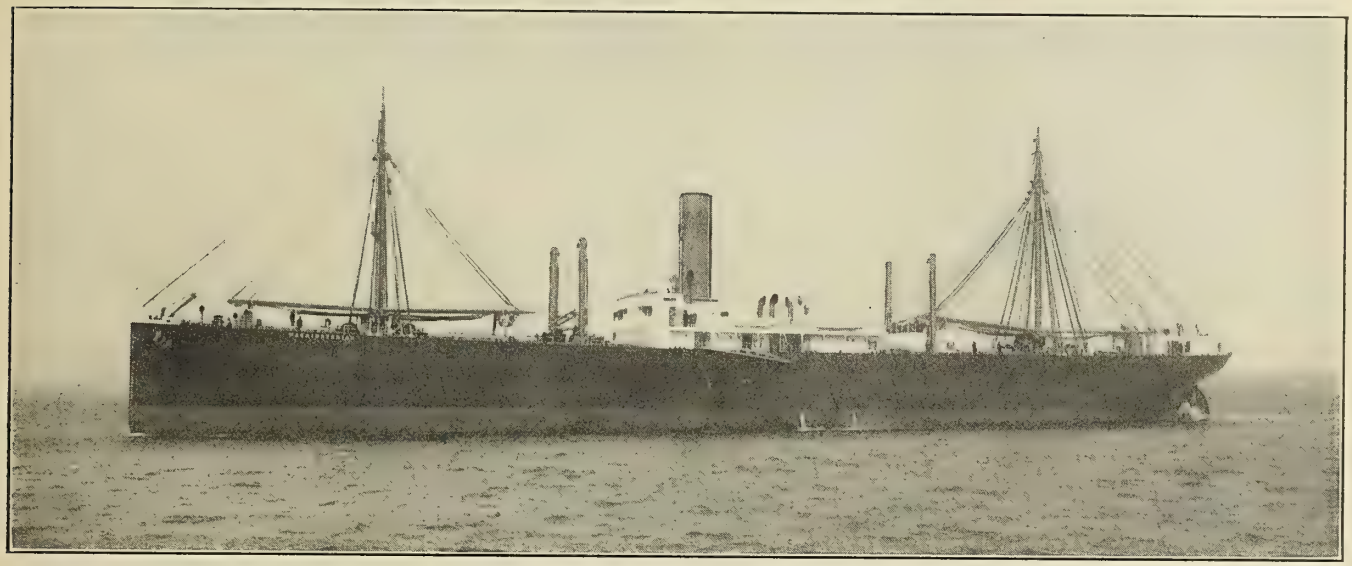
Self-Unloading Lake Freighter *W. F. White*, Built by the American Shipbuilding Company, Cleveland, Ohio, for the Limestone Transportation Company



Bulk Freighter *Howard M. Hanna, Jr.*, Built by the American Shipbuilding Company, Cleveland, Ohio, for the Hanna Transit Company, Cleveland, Ohio



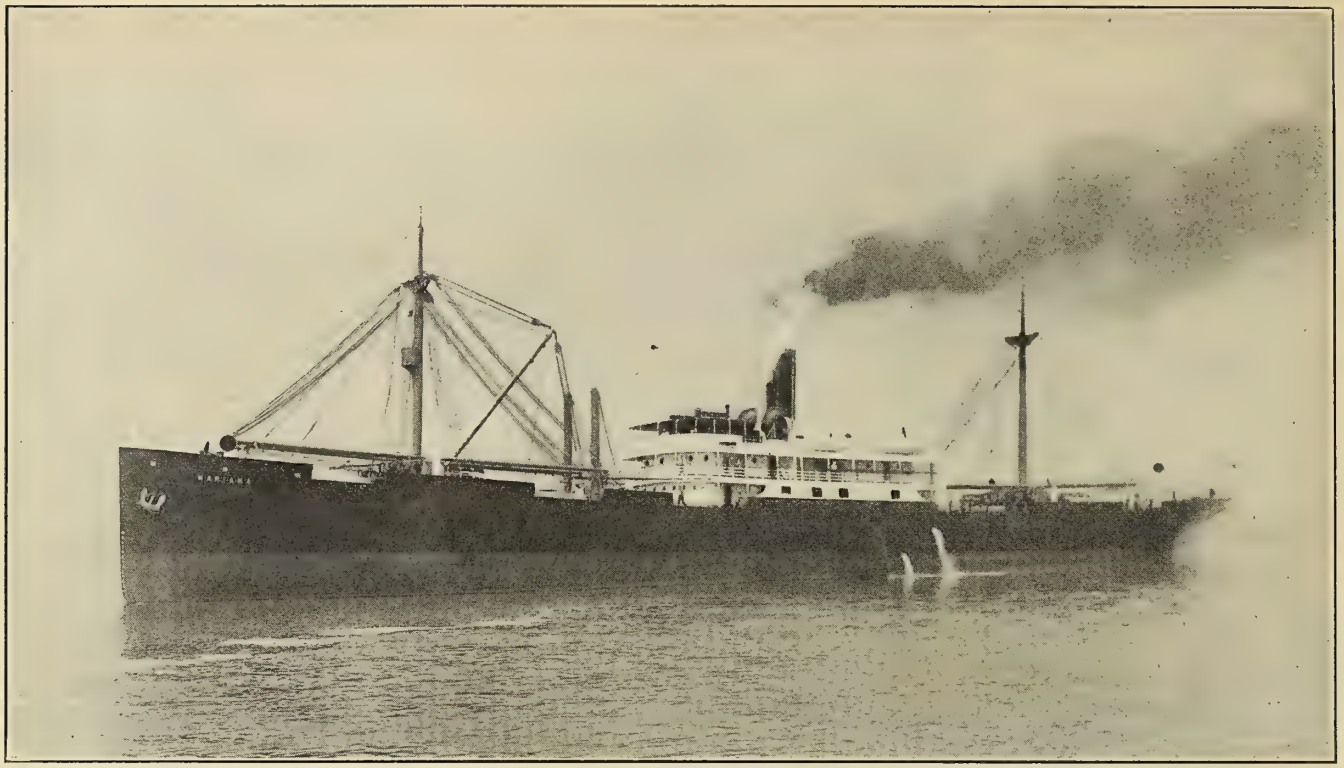
S. S. *Franklin*, Built by the New York Shipbuilding Company for the Coastwise Transportation Company, Boston, Mass.



S. S. *Washingtonian*, Built by the Maryland Steel Company, Sparrows Point, Md., for the American-Hawaiian Steamship Company, New York



S. S. *Edith*, Built by the Maryland Steel Company, Sparrows Point, Md., for the A. H. Bull Steamship Company, New York



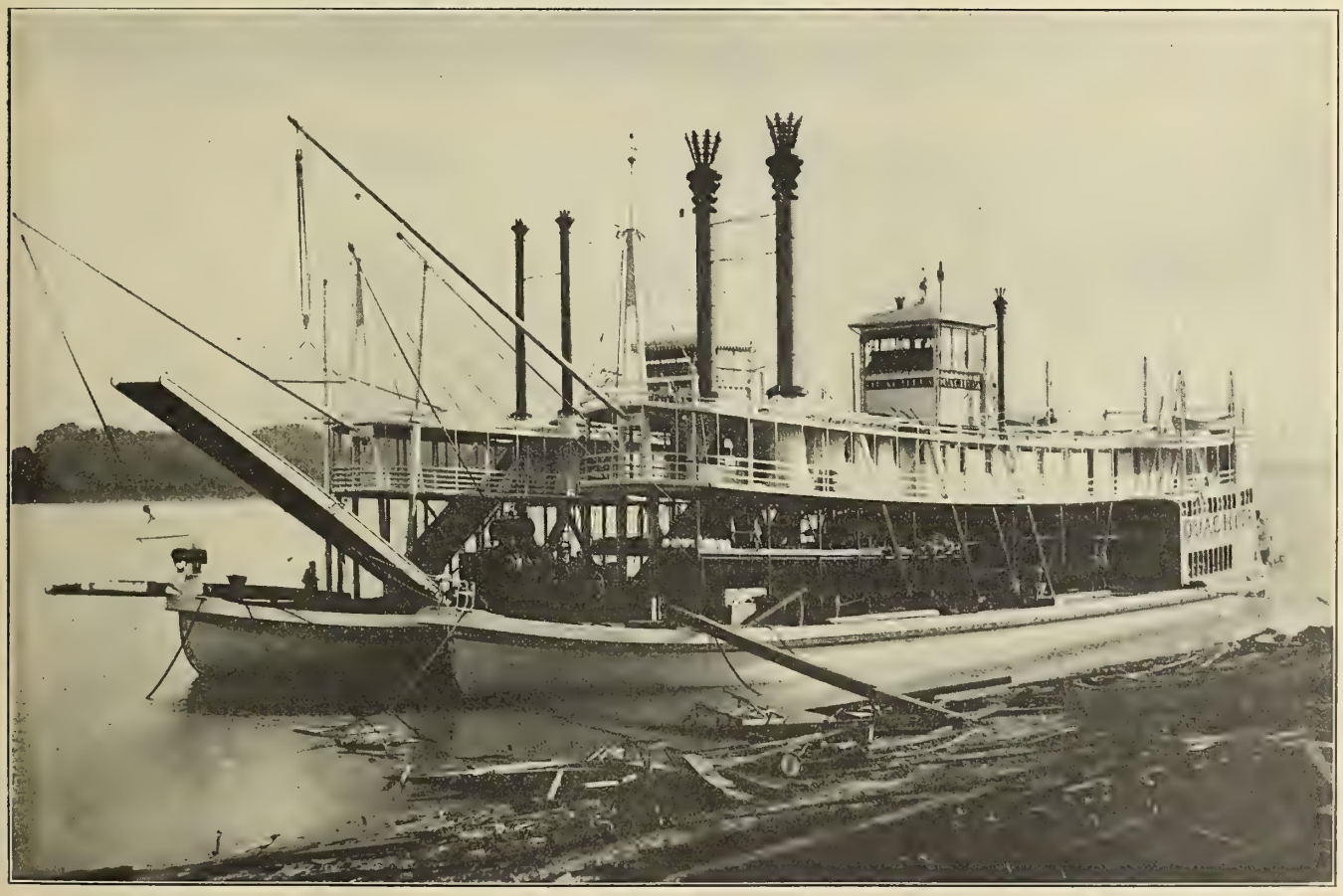
S. S. *Mariana,* Built by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., for the New York & Porto Rico Steamship Company, New York



United States Battleship *Texas,* Built by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va.



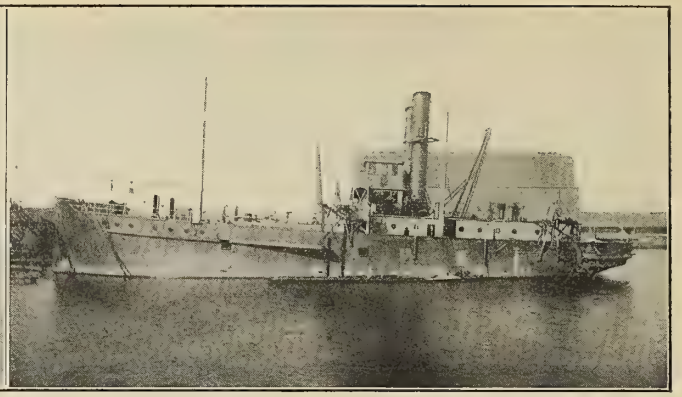
S. S. *Walter D. Noyes*, Built by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., for the Crowell & Thurlow Steamship Company, Boston, Mass.



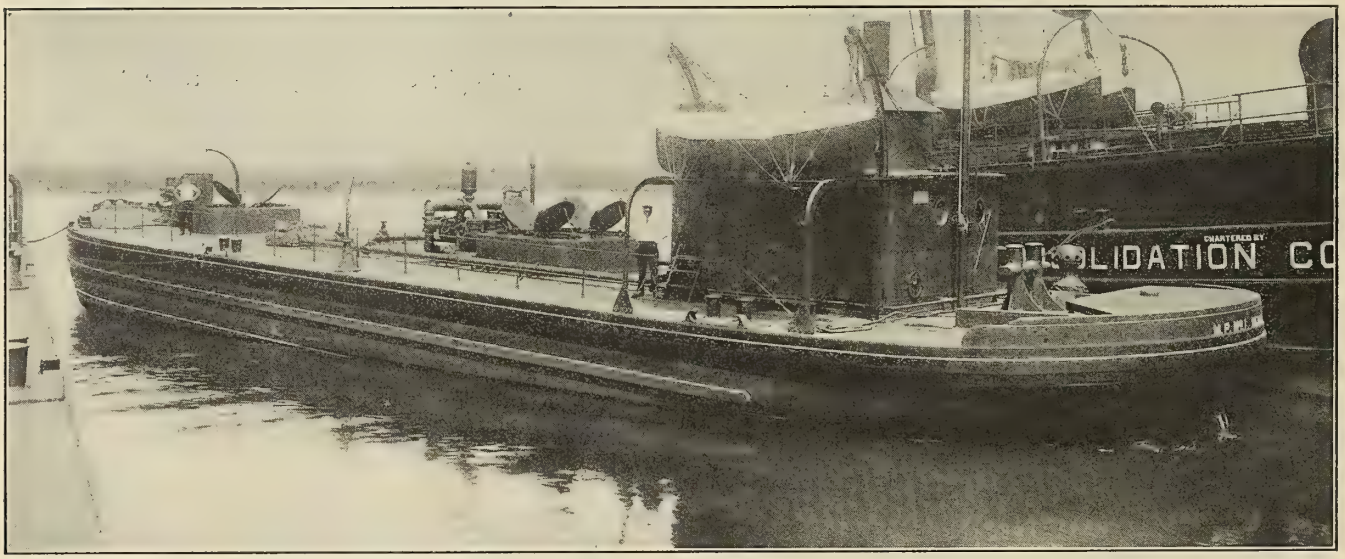
Mississippi River Cotton Boats, Built by the Howard Ship Yards Company, Jeffersonville, Ind.



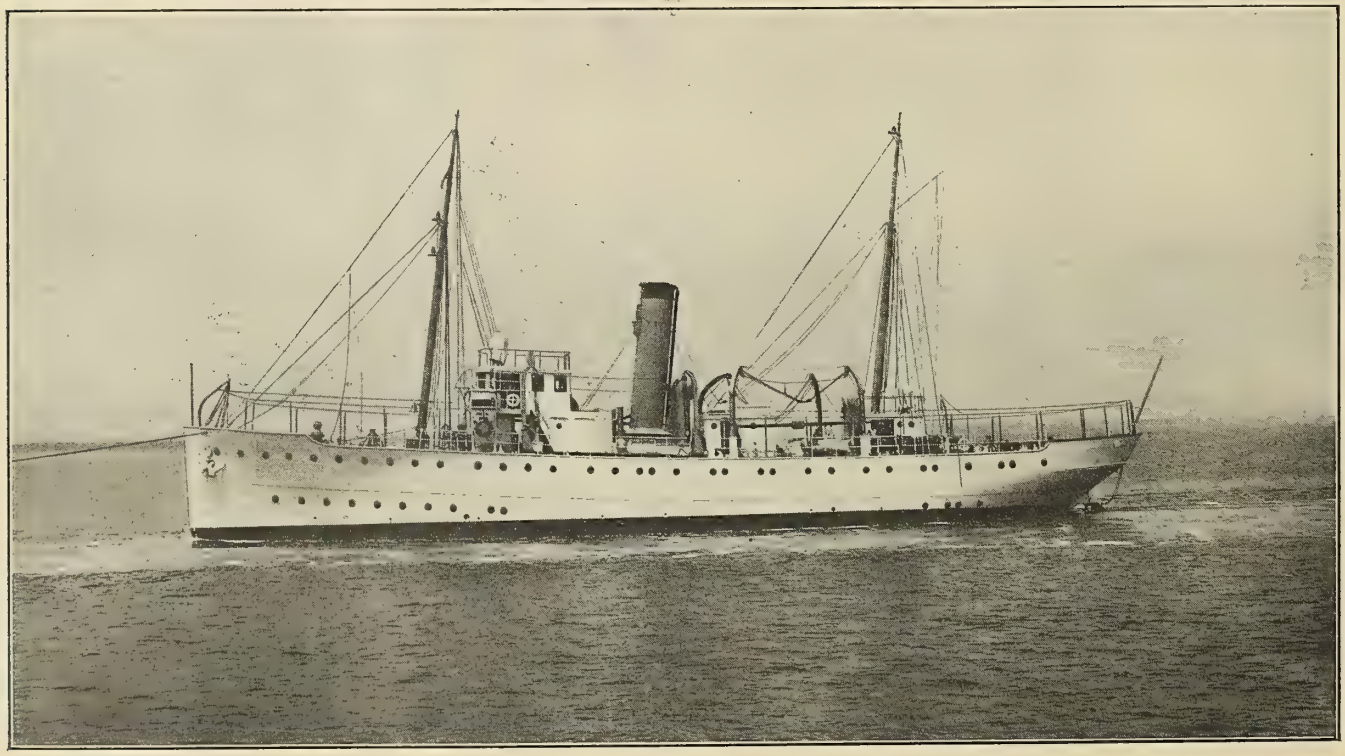
U. S. S. Dredge *Col. P. R. Michie*, Built by the Seattle Construction & Dry Dock Company, Seattle, Wash.



Sea-going Hopper Dredge *San Pablo*, Built by the Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md.



Oil Barge Built by the Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md., for the Huasteca Petroleum Company, New York



U. S. Coast Guard Cutter *Ossipee*, Built by the Newport News Shipbuilding & Dry Dock Company, Newport, News, Va.

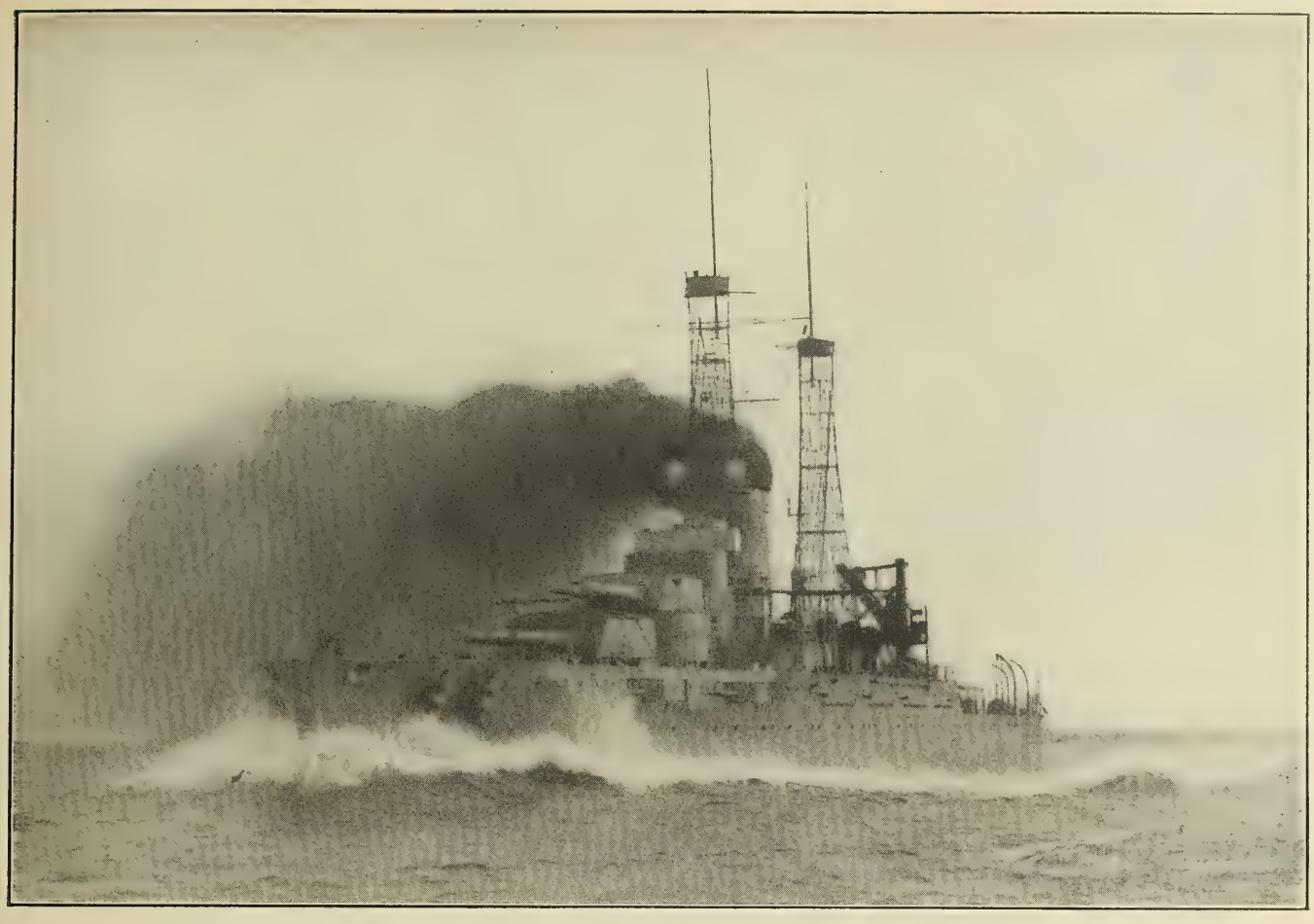


Fig. 1.—The *Nevada*, Making 21.04 Knots on Her Official Trials

United States Battleship Nevada

Built by the Fore River Shipbuilding Corporation and Equipped with Curtis Turbines

The battleship *Nevada*, with her sistership the *Oklahoma*, was authorized by an Act of Congress, approved on March 4, 1911. The contract for the construction of the *Nevada* was placed with the Fore River Shipbuilding Corporation, Quincy, Mass., on January 22, 1912, the price being $5,879,000 (£1,205,000) exclusive of armor and armament and the time of construction 36 months.

The *Nevada* is a twin screw vessel fitted with Curtis turbines, designed for a speed of 20½ knots at 27,500 tons trial displacement with the engines developing 26,500 shaft horsepower. A supplementary contract was made with the builders on June 31, 1914, increasing the contract price $50,000 (£10,250) and the time of construction 5 months, in order to cover the installation of a geared cruising turbine on each shaft, and at the same time changes were made by the builders in the design of the main turbines, reducing the numbers of rows of blades, increasing the blade clearances and changing the method of securing the blades.

The principal dimensions of the *Nevada* are as follows:

Length over all	583 feet
Length between perpendiculars	575 feet
Beam, molded	94 feet 10⅛ inches
Depth, molded at side to main deck	44 feet 5½ inches
Load draft	28 feet 6 inches
Mean trial displacement	27,500 tons
Tons per inch immersion at load waterline	93.2 tons
Area of midship section	2,665 square feet
Area of load waterline plane	39,160 square feet
Area wetted surface	65,700 square feet
Coefficient of fineness	0.6168

The vessel has a single smokestack and two cage masts.

The main armament consists of ten 14-inch guns, arranged in four turrets on the centerline of the ship. The two forward turrets are located on the upper deck and the two after turrets on the main deck. The extreme forward and after turrets have three guns each and the other turrets two guns each. The turrets are electrically operated through variable speed gear.

The secondary battery consists of twenty-one 5-inch guns, located, seven on the second deck, twelve on the main deck and two on the superstructure deck. There are also four air defense guns; four 3-pounder guns for saluting; two 1-pounder guns for boats; two 3-inch field pieces, and two 30-calibre machine guns.

The captain's quarters are on the upper deck abaft the second turret, while the officers' quarters are forward on the main and second decks. Amidships on the second deck are the principal executive offices. The galleys for the officers and crew are on the main deck. In the space around the uptake on the third deck are a foundry and coppersmith and blacksmith shops.

Propulsion is by Curtis turbines, arranged on two

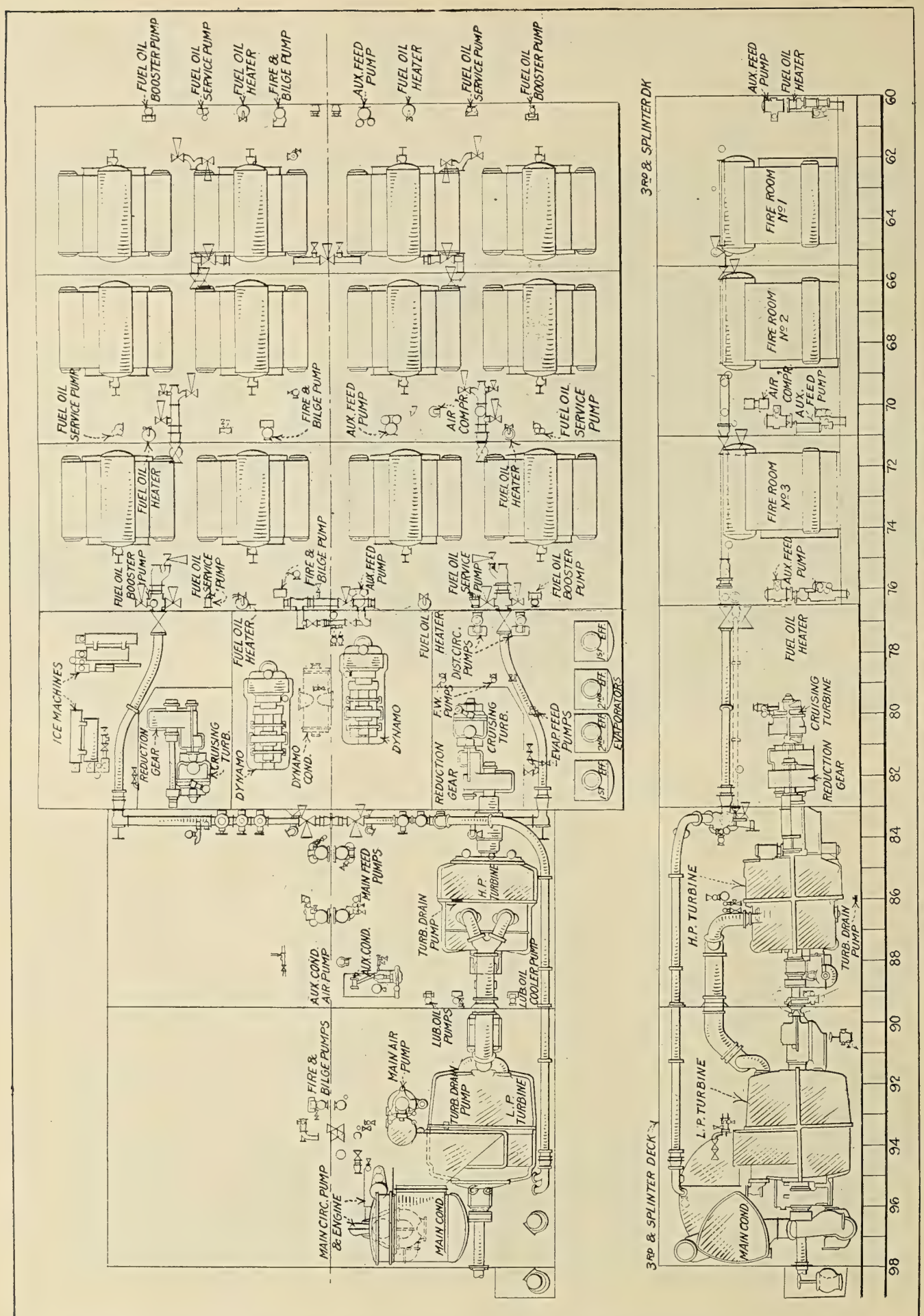


Fig. 2.—Diagram Showing Plan and Elevation of Boiler and Engine Rooms of the *Nevada*

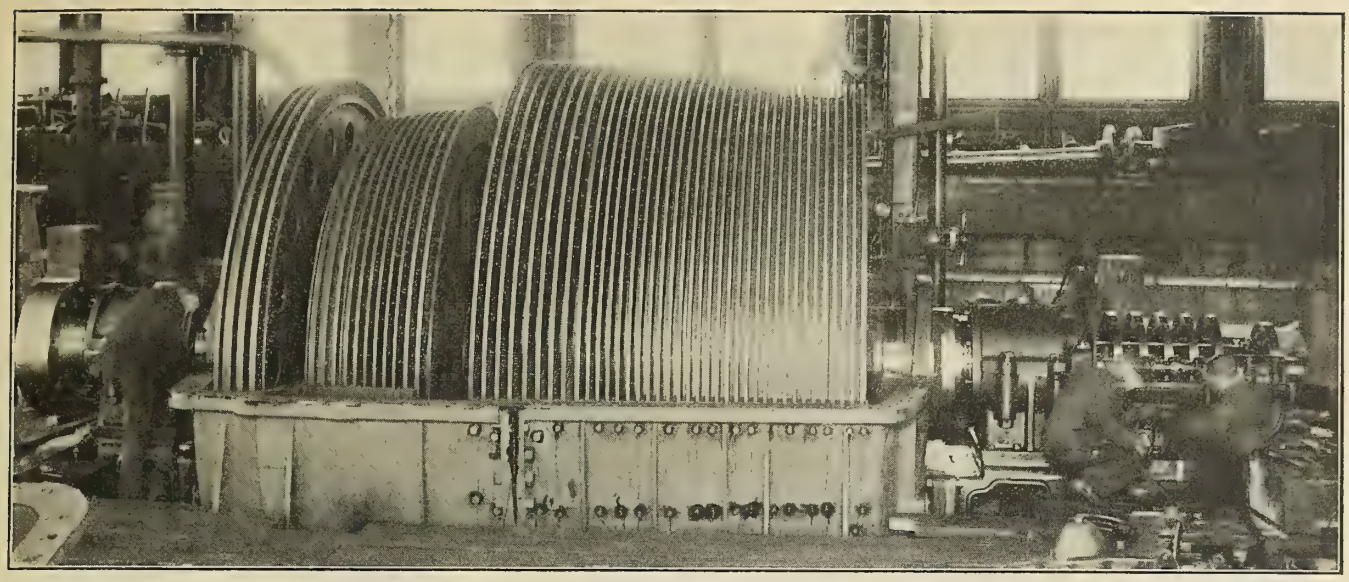


Fig. 3.—Low-Pressure Turbine with Astern Turbine

shafts in four watertight compartments, supplied with steam at 295 pounds per square inch pressure from twelve Yarrow watertube boilers arranged in three watertight compartments.

As shown on the plan, Fig. 2, in each forward engine room there is a geared cruising turbine connected to the main shaft by means of a jaw clutch, and one 132-inch diameter high-pressure turbine. In each after engine room there is one 138-inch diameter low-pressure turbine and a reversing turbine in a single casing. The main turbines are designed to develop, collectively, 26,500 shaft horsepower at about 222 revolutions per minute. The cruising turbines are designed to develop 1,750 shaft horsepower each at 3,200 revolutions per minute and are geared down in the ratio of 23.85 to 1. The cruising units may be used at all speeds ahead below 15½ knots but are disconnected for higher speeds and when reversing.

Each high-pressure turbine consists of five wheel stages, a forward and an after drum. The first stage consists of four moving rows and the other wheel stages have two moving rows each. The five stage wheel is secured to the forward end of the forward drum, which has nine single row stages, while the after drum has sixteen single row stages. The two drums are so designed as to practically balance the steam thrust in the high-pressure turbine at all speeds.

The low-pressure turbines consist of a drum with thirty-eight single row stages. The reversing turbines, incorporated in the same casings as the low-pressure turbines, consist of one stage with four moving rows of blades, one

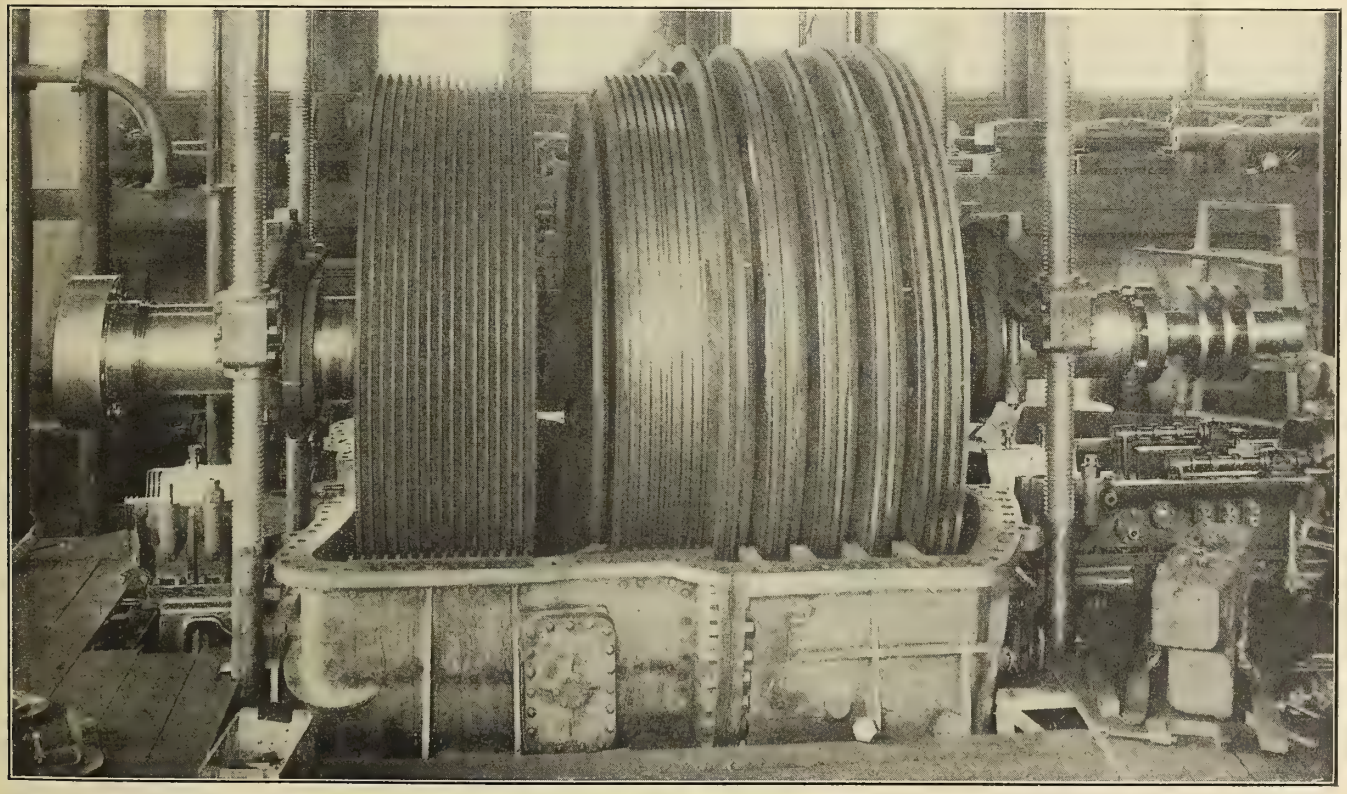


Fig. 4.—High-Pressure Turbine

stage with three moving rows of blades and a drum with eight single row stages. The second stage wheel is integral with the drum.

Steam is supplied to the high-pressure turbine through two 9-inch throttle valves and 9-inch pipes, one leading to each of the full-power steam chests. Steam to the cruising chest is supplied through a 5-inch throttle and a 5-inch pipe. For reversing steam is supplied through a 13-inch throttle and a 13-inch pipe to the after-engine room, where the pipe is divided into two 9-inch pipes, leading to the steam chests on the after end of the low-pressure turbines.

For going ahead with the main turbines only in use steam is supplied to the forward engine rooms through either one or both of the 9-inch pipes or the 5-inch cruising connections to the ahead steam chests, thence through the first, second, third, fourth and fifth wheel stages and the forward drum; thence out through four 11-inch receiver pipes to the steam belt on the after end of the high-pressure turbine and forward through the after drum to the exhaust belt of the high-pressure turbine. From there it exhausts through two 20-inch pipes which combine into one 28-inch pipe and exhaust to the low-pressure turbines. In the after-engine room this pipe divides into two 20-inch pipes which lead to the steam belts on the ahead end of the low-pressure turbines. The steam then passes through the low-pressure turbines to the exhaust belt, thence through the exhaust trunk to the condenser.

When the cruising turbines are in use steam is supplied from the main steam pipe to the cruising turbines, thence to the first stage of the high-pressure turbines, thence through the second, third, fourth and fifth stages, as is the case when operating under the main turbines only. The exhaust from the cruising turbine leads to the first stage of the high-pressure turbine and therefore does no work in this stage. A cruising connection of the high-pressure steam chest is provided, however, so that speeds slightly in excess of those given by the steam that passes through the cruising turbine can be obtained.

The turbine wheels are built up of two steel plate disks riveted to a cast-steel spider. The wheel rims are of forged steel except for the first stage ahead and astern, which are cast steel. The drums consist of cast-steel spiders, forced on and keyed to the rotor shafts, with heads of steel plate and rims of forged steel. The diaphragms are of dished steel plate with cast-steel rims and hubs. Leakage of steam and air around the shaft, where it passes through the casings, is prevented by steam-sealed carbon packing stuffing boxes.

The turbine blades and the distance pieces which separate them are of rolled brass, dovetailed into grooves in the periphery of the wheels and rims. The shrouding for the blades is also of rolled brass. In the high-pressure turbine the length of the blades ranges from 1.46-inch in the first row of the first stage to 1⅞ inches in the third row on the fifth stage, and from 1⅝ inches to 1⅞ inches on the forward drum, and from 2½ inches to 3⅞ inches on the after drum. In the low-pressure turbine the length of the blades ranges from 4⅝ inches in the first stage to 13½ inches in the last stages. In the reverse turbines the blades range from 1.76 inches in length in the first high-pressure stage to 8 inches in the last stage.

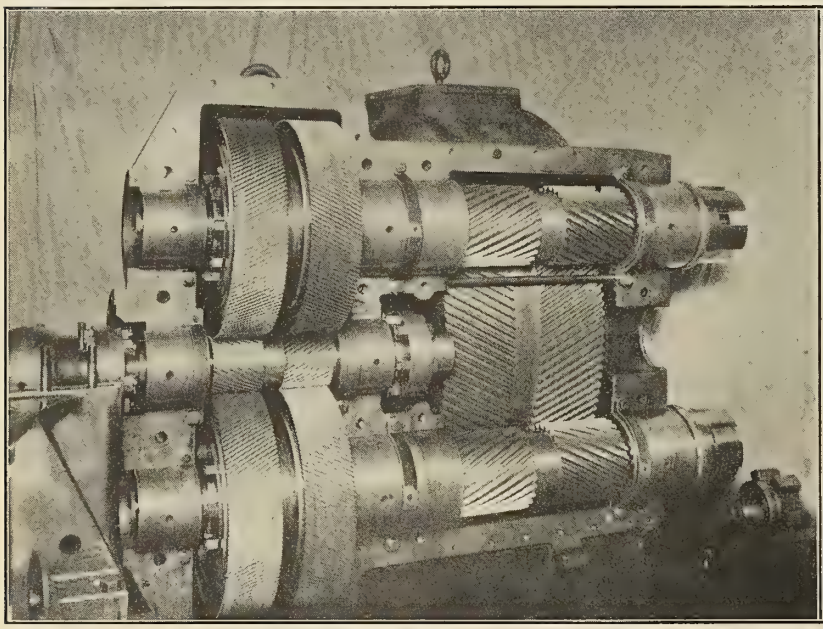


Fig. 5.—Reduction Gear for Cruising Turbine

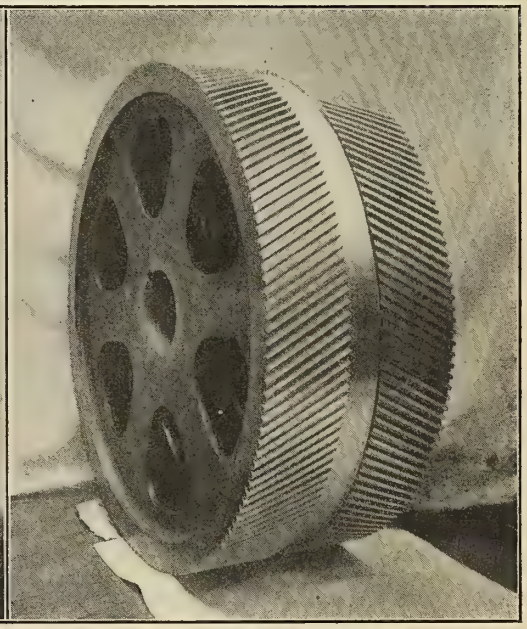


Fig. 6.—Main Gear Wheel

Nozzles for the first stage ahead and the first stage astern are of composition, the openings being accurately machined and filed to template. Nozzles for the second to the fifth stages ahead and the second stage astern are of composition with Monel metal division plates. The nozzles for the first stage ahead and first stage astern are expanding, while all others are parallel wall nozzles.

The cruising turbines and reduction gears were manufactured by the General Electric Company, Schenectady, New York. The turbines are of the three-stage Curtis type, designed to develop 1,750 shaft horsepower at 3,200 revolutions per minute, with steam at 250 pounds gage and exhausting against a back pressure of about 5 pounds gage. All stages in the turbines are wheel stages. The turbines and gears for each of the two shafts are identical and turn in the same direction, but in order to turn the port shaft outboard when going ahead the port unit is turned around and a section of line shafting placed between the main gear shaft and the high-pressure thrust shaft.

The gears are of the double-reduction type, the main pinion of the turbine shaft driving the gears on the two intermediate shafts, while the pinions on the latter drive the main gear wheel. The faces of all pinions and gears

are divided into two parts with the teeth cut at opposite angles in order to balance the thrust. The teeth are cut at an angle of 27 degrees with the axis; both the main and intermediate pinions are forged solid on the sleeve, which fits around the shaft. The intermediae gears are built up, each section consisting of five steel disks securely bolted together. The main gear is of cast iron, with a forged-steel rim in which the teeth are cut.

The propellers are 3-bladed of manganese bronze, cast solid with a diameter of 14 feet 3 inches, a pitch of 12 feet, a projected area of 71.5 square feet, a helicoidal area of 81.5 square feet, a disk area of 159.48 square feet, with a ratio of projected area to disk area of .4483 and of helicoidal area to disk area of .51.

As previously mentioned, steam is furnished at 295 pounds gage pressure by twelve Yarrow watertube boilers, arranged in three watertight compartments. Each boiler has a heating surface of 4,000 square feet with a furnace volume of 625 cubic feet. Oil fuel is used exclusively in firing the boilers, seven Fore River burners being fitted to each boiler. Forced draft is provided by twelve Sturtevant multivane fans in each fireroom. Each fan has a rated capacity of 16,000 cubic feet of air per minute when discharging against a back pressure equal to 5 inches of water and each fan is driven by a direct connected General Electric motor of 32 horsepower.

There is one main condenser in each after-engine room, having a cooling surface of 9,900 square feet, provided with a Blake vertical twinplex single-acting air pump 18½ by 40 by 21 inches. The circulating pumps are of the centrifugal type, with a capacity of about 22,500 gallons per minute, driven by vertical compound reciprocating engines.

Auxiliary condensers of 405 square feet cooling surface each are provided in each forward-engine room with Blake vertical double-acting air pumps, 6 x 10 x 8 inches, and centrifugal circulating pumps driven by a single vertical reciprocating engine. In each forward room there is also a Reilly vertical multicoil feed water heater of 319.8 square feet heating surface for use with the main feed pumps. The main feed pumps are of the Blake vertical double-acting type, while in the after-engine rooms are Blake vertical double-acting single fire and bilge pumps.

The electric plant consists of four 300-kilowatt General Electric generators connected to 2-stage horizontal Curtis turbines. Two of the generators are located in a forward dynamo room and the other two in an after dynamo room. The condensing apparatus for each dynamo room is located directly under the dynamo rooms and a separate distribution room is located directly overhead each dynamo room. Each generator is capable of delivering one-third overload for two hours without injury.

The evaporating and distilling apparatus consists of four Reilly horizontal multicoil evaporators, two Reilly vertical multicoil distillers, two Reilly U-type Bureau standard feed water heaters, two distiller circulating pumps, two evaporator feed pumps and two fresh water pumps together with the necessary accessories. The plant has a rated capacity of 25,000 gallons of water in 24 hours and is arranged to operate in double effect.

Ventilation throughout the ship is provided by forty-eight Sturtevant ventilating fans driven by General Electric motors. Air is supplied on the plenum system and heater boxes are fitted in the ventilating ducts to all quarters below the upper deck, crew's spaces, etc., for heating the incoming air.

The refrigerating plant consists of two horizontal steam-driven Allen condensed air machines, manufactured by H. B. Roelker of New York. Each machine is capable of producing the cooling effect of three tons of ice per day.

The deck machinery includes three motor-driven deck winches, electrical-driven anchor gear and motor-driven capstan, and both steam and electric steering gear, all of which is supplied by the American Engineering Company of Philadelphia.

Trials of Geared Turbine Propelling Machinery on Freight Steamer Pacific

Vessel Equipped with Curtis Five-Stage Geared Turbine of 2,400 Horsepower Supplied with Superheated Steam from Scotch Boilers

The standardization trials of the steamship *Pacific*, recently built by the Union Iron Works, San Francisco, Cal., for Norwegian owners, were held on November 21, 1915, over the measured mile trial course off Bluff point, in San Francisco Bay. This vessel is of special interest at this time, as she is one of the first large general cargo steamers of moderate speed built in the United States to be equipped with geared turbine propelling machinery.

The *Pacific* is 418 feet long over all, 400 feet long between perpendiculars, with a molded beam of 56 feet and a molded depth to upper deck of 32 feet. In light condition, with a draft of 8 feet 3½ inches, the displacement is 3,540 tons, and the tons per inch of immersion 41.17. In loaded condition, with a draft of 25 feet 4 inches, the displacement is 12,500 tons, and the tons per inch of immersion 46.16. The main characteristics of the hull in both the light and loaded conditions are shown in the following table:

	Light	Loaded
Block coefficient	.673	.773
Prismatic coefficient	.712	.790
Area of midship section	435	1,385
Coefficient of midship section	.942	.930
Area of water plane	17,330	19,390
Center of buoyancy above base	4.96	13.8
Transverse metacenter above base	36.4	24.28
Longitudinal metacenter above base	1,890	473

Propulsion of the vessel is by a Curtis 5-stage geared turbine supplied by the General Electric Company, Schenectady, N. Y., and designed to develop 2,400 shaft horsepower at 3,500 revolutions of the turbine and 90 revolutions per minute of the propeller shaft. Steam is supplied at a pressure of 210 pounds per square inch by three single-ended, three-furnace Scotch boilers, 14 feet 9 inches inside diameter and 11 feet long. Each boiler has a heating surface of 2,685 square feet, and is fitted with superheaters of the Union Iron Works Company's type.

The propeller is of the built-up type with a cast iron hub and four composition blades with a diameter of 16 feet 6 inches, a pitch of 14 feet and an expanded area of 77.04 square feet.

The following tables give the pump data and a list of the auxiliary machinery:

Pump Data	
1 Main air pump	Vertical twin beam, 14 ins., 28 ins., 18 ins.
1 Circulating pump	U. I. W. Co.'s centrifugal, 14 ins. dia., 42-in. runner
1 Main feed pump	De Laval turbine, 37 H. P.
1 Auxiliary feed pump	De Laval turbine, 37 H. P.
1 Fire and bilge pump	Duplex horizontal, 12 ins., 8½ ins., 12 ins.
1 Ballast pump	12 ins., 10½ ins., 12 ins.
1 Trimming pump	10 ins., 7 ins., 10 ins.
1 Sanitary pump	7½ ins., 5 ins., 6 ins.
1 Fresh-water pump	7½ ins., 5 ins., 6 ins.
1 Evaporator pump	4½ ins., 2¾ ins., 4 ins.
1 Engine room bilge pump	6 ins., 5¾ ins., 6 ins.
2 Fuel oil pumps	6 ins., 4 ins., 6 ins.

Auxiliary Machinery	
1 Circulating pump engine	10 ins. x 10 ins.
1 Steam tiller	Brown type, 7½ ins x 12 ins.
1 Capstan	8 ins. x 10 ins.
1 Windlass	10 ins. x 16 ins.
11 Winches	Ten 7 ins. x 10 ins.; 1-9 ins. x 12 ins.
2 Generators	G. E. Co.'s 15-horsepower turbine, 10 kilowatt
1 Feed-water heater	U. I. W. Co.'s type
1 Evaporator	12 ton
1 Ice machine	Vulcan Iron Works type

On the standardization trials of the vessels, which were held on November 21, the ship left the builders' wharf at 9:15 A. M., and after the compasses were adjusted, headed for the California city course at 10:05 A. M. The four-hour run was begun at 11 o'clock. Two double runs were made over the course, and then the vessel was headed out for a short run at sea. The four-hour run was finished at 3 P. M., and the vessel landed at the builders' whartf at 4:15. The draft of the ship was 6 feet forward and 16 feet 1 inch aft, making the mean draft 11 feet ½ inch. The fuel oil consumed per shaft horsepower per hour, allowing 10 percent for the auxiliaries, figured out at .83 pound. Referring to the indicated horsepower and allowing 10 percent for the auxiliaries, the fuel oil consumption was .73 pound per horsepower-hour. The data taken on these trials are shown in Table I.

Table I.—Standardization Trials, S.S. Pacific

	Mean of 2 Double Runs Over Measured Mile	4-Hour Trial at Sea
Speed, knots	13.1	.....
Slip, percent	—0.05	.....
Revolutions per minute	89	88.5
Horsepower	2,360	2,355
Boiler pressure, pounds per square inch	207	207
Vacuum, inches	29	29
Temperature, superheated steam, F.	420	420
Temperature, saturated steam, F.	390	385
Temperature of feed water, F.	175	180
Temperature in stack, F.	675	672

On December 13 and 14 the *Pacific* made a voyage from Seattle to San Pedro, and during this voyage the data given in Table II were taken.

Table II.—Data Taken on Voyage From Seattle to San Pedro

	Dec. 13-14	Dec. 14	Dec. 14	Dec. 14
Speed, knots	10.88	11.2	10.5	9.8
Revolutions per minute	85.9	86.	81.	77.
Shaft horsepower	2,450	2,450	2,030	1,725
Boiler pressure, pounds per sq. in.	200	200	200	190
Vacuum, inches	29¾	29½	29½	29½
Temperature, superheated steam, F.	410	....	....	....
Temperature, saturated steam, F.	390	....	....	....
Temperature, feed water, F.	208	205	205	210
Temperature in stack, F.	590	630	630	630
Pounds of oil per shaft horsepower hour, allowing 10 percent for auxiliaries	0.95	0.97	1.001	1.07

While on the trial trip the *Pacific* was carrying only 500 tons load. Some additional data are available, which were taken on a trip from Seattle after the ship had taken on a full cargo of 8,300 tons, the results of which are given in Table III.

Table III.—Three-Hour Full-Load Test at Sea

Speed, knots	11.5
Revolutions per minute	87
Draft of vessel, feet	25
Load, tons	8,300
Steam pressure at turbine, pounds per square inch	207
Vacuum, inches	28
Horsepower, average	2,655
Pounds of oil per brake horsepower-hour	0.875
British thermal units per brake horsepower-hour	16,420

During the trial run in light condition the reduction gears were noisy, but, with the increased draft on the run in full load condition, the operation of the gears, as regards noise, was greatly improved. The complete immersion of the propeller insured a steady load on the gears, with the result that the noise noticeable in the trial test was gradually reduced, so that it was practically unnoticeable anywhere about the ship, and was a matter of no inconvenience even in the engine room. After the trial trip a larger oil cooler was installed, and it is considered probable that the increased quantity of oil which is now being sent through the gears, due to the use of a larger cooler, has a material effect in giving smoothness in the operation of the gears.

From the data given above it will be noted that a speed of 11.5 knots was obtained at 87 revolutions per minute of the propeller, which indicated that the pitch of the propeller is slightly high for the speed and horsepower of the turbines. This will be remedied in future boats by decreasing the propeller pitch to such a point that a speed of 11.5 knots will be secured at about 90 revolutions. This should result in a gain in the efficiency of the propeller and improve the operation of the ship when lightly loaded.

The propelling machinery of the *Pacific* has proved satisfactory in every respect, and the captain and chief engineer of the vessel have been enthusiastic in their praise of the equipment, and consider that the *Pacific* is by far the most economical vessel of its capacity on the Pacific Coast. Considering the fact that this design of the turbo-gear propelling machinery is new throughout and that the machinery was installed in less than ten days, and that the ship was put into commission the day after she was finished, and left immediately on a voyage of several months' duration around Cape Horn, it will be appreciated that the turbine and reduction gears have been given a very severe test. The satisfactory results and the economy gained will, therefore, be of much interest to all steamship owners and should pave the way for a wider adoption of this type of machinery in modern slow-speed vessels.

Successful Installation of Fire-Tube Superheater on a Railroad Tug

The first fire-tube superheater installed on an American boat operating in American waters has just shown that it can effect a saving of 15⅝ percent in coal consumption and gain other advantages for the vessel, as compared with one using saturated steam.

The installation was made on the Lehigh Valley Railroad tug *Wyoming*, a vessel of 398 gross tons, 152 feet long, 27 feet 3 inches beam and 16 feet draft, with a towing capacity of 5,000 tons. Propulsion of the tug is by a triple-expansion engine, with cylinders 17 inches, 25 inches and 43 inches diameter, with a stroke of 30 inches, supplied with steam at a pressure of 180 pounds per square inch by a single Scotch boiler fitted with a fire-tube marine superheater supplied by the Locomotive Superheater Company, New York.

The use of superheated steam in marine practice has been indulged in by European owners quite extensively during the past six years, and the successful results obtained have been responsible for the policy becoming more and more widely adopted. At the present time European owners have over 2,500,000 horsepower afloat in boats equipped with Scotch boilers and high-degree superheaters. In America, however, notwithstanding the fact that industrial plants almost universally employ superheated steam, and over 15,000 locomotives are operating with 225 to 250 degrees of superheat, the marine engineers and shipowners have been somewhat dilatory in accepting the advantages offered by high-degree superheating.

The Lehigh Valley Railroad Company, operating as it does some 238 locomotives equipped with high-temperature superheaters, and appreciating the possibilities offered, recently installed superheater equipment in their tug *Wyoming*. The *Wyoming* has been operating now for three months, using superheated steam, and during that time has been in daily service, towing barges laden with as much as 4,800 tons of coal, between Perth Amboy, N. J., and the New England coast. To ascertain accurately the advantages of the superheater in this boat, its coal was carefully weighed daily and every precaution



Fig. 1.—Lehigh Valley Tug Wyoming

taken to insure that no false results or improper conclusions would be reached. At the end of three months the *Wyoming* showed a saving of 15⅝ percent in fuel as compared with a similar three months in identical service, but using saturated steam.

In addition, the boat has been kept going all the time; in other words, its efficiency in getting coal from New Jersey to New England has been greatly increased.

As noted above, the application of a high-degree super-

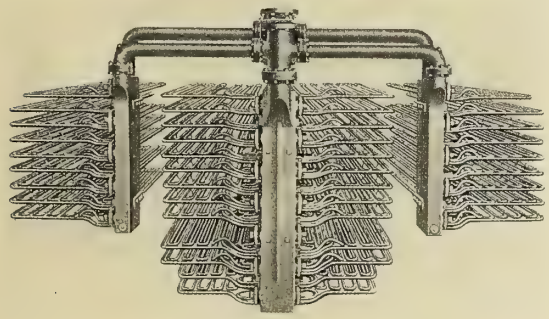


Fig. 2.—Superheater Units Assembled

heater to Scotch boilers in marine service was without precedent on this side of the water, and therefore was looked upon somewhat in the nature of an experiment. The results obtained, however, have corroborated those obtained by a large number of European owners, and the Lehigh Valley Railroad Company has not only announced that the superheater on the *Wyoming* is there to stay, but it is planning to equip the remaining vessels of its fleet as rapidly as conditions will permit.

The boiler plant of the *Wyoming* consists of one four-furnace Scotch marine boiler, 15 feet in diameter and 12 feet long over all, with a distance between the tube sheets of 8 feet 3 inches. This boiler has a total grate area of 86.6 square feet, a boiler evaporative surface of 2,926 square feet, and in addition a superheating surface of 758 square feet.

The fire-tube superheater in the *Wyoming* consists of three pairs of collector castings or headers, located at the uptake end of the boiler, each pair of headers being connected to a group or nest of superheater unit pipes, which run in and out of the boiler smoke tubes. Of each pair of headers one takes the saturated steam as it comes from the boiler and transfers it to the superheater units; the

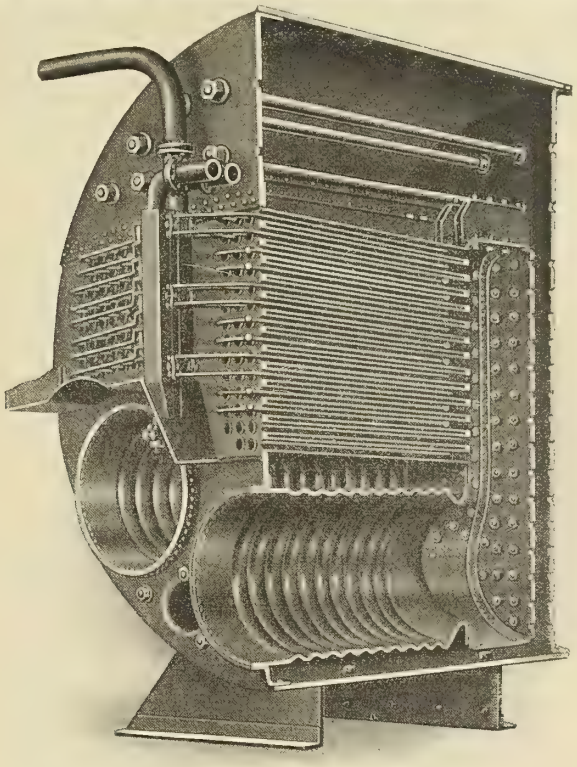


Fig. 3.—Section of Scotch Boiler, Showing Installation of Superheater

other receives the superheated steam after it has passed through the units on its way to the engines.

In this superheater there is a total of 80 units, arranged in three groups, corresponding to the number of pairs of headers. These groups, each made up of a saturated and a superheated header, with a system of units, are independent in their action, being separated from each other by valves, which can be closed if necessary.

The degree of superheat obtained can be governed by a mixing pipe, which cools the superheated steam to any desired temperature by admitting the proper amount of saturated steam to the main steam pipe. The average steam temperature obtained with this superheater is about 565 degrees, which, with a steam pressure of 180 pounds, is equivalent to 185 degrees of superheat. A maximum steam temperature of 620 degrees, corresponding to 240 degrees of superheat, has been successfully maintained for periods of several hours' duration.

In order to operate the power plant with the greatest efficiency, two pyrometers are used to indicate the degree of superheat that is being obtained. One of these instruments is located in the boiler room and is connected in the main steam pipe, near the superheater header, while the other is connected to the main steam pipe just above the throttle in the engine room. By means of these pyrometers the engineer can always know the conditions under which his boilers are operating.

New Luckenbach Freight Steamers

Two Single Screw and Two Twin Screw Vessels to be Propelled by Curtis Geared Turbines

Four large freight steamers are now under construction at the yards of the Fore River Shipbuilding Corporation, Quincy, Mass., for the Luckenbach Steamship Company, New York. All four of these vessels will be driven by high-speed Curtis turbines, driving the propellers through speed reduction gears. Two of the vessels are single screw and two twin screw. The single screw vessels are of 10,000 tons and the twin screw vessels of 10,500 tons deadweight carrying capacity. They are designed for a speed of 13½ knots on a 28-foot draft. The principal dimensions of the single screw vessels are as follows:

Length overall	456 feet
Length between perpendiculars	437 feet 6 inches
Beam, molded	57 feet
Depth, molded	41 feet 6 inches

The twin screw vessels are slightly larger, as shown by the following dimensions:

Length overall	469 feet
Length between perpendiculars	447 feet
Beam, molded	55 feet 11 inches
Depth, molded	40 feet 8 inches

The vessels are built according to designs by Mr. J. L. Luckenbach, vice-president of the Luckenbach Steamship Company, and are classed by Lloyd's and the American Bureau of Shipping.

Propelling Machinery of Single Screw Vessels

The propelling machinery of the single screw vessels is located amidships and consists of a Curtis turbine, driving a high and low speed reduction gear designed to deliver 4,000 shaft horsepower at 90 revolutions of the propeller shaft. The maximum shaft horsepower will be 4,500, with the revolutions of the propeller not exceeding 93.

The turbine is designed to operate with a steam pressure of 195 pounds in the steam chest and against a vacuum of 28 inches.

The turbine is so arranged that the ahead and reverse turbines are carried on one shaft and contained in one casing. The astern turbine will be capable of delivering to the shaft not less than 50 percent of the power of the ahead turbine. The revolving element will be so designed as to stand an overspeed of 20 percent above the full speed.

The total reduction of speed between the turbine and the propeller shaft will be in two steps, the system employed being what is known as the double drive type—that is, the pinion will drive two gears, one diametrically opposite the other, thereby eliminating pressure on the pinion bearings and insuring perfect tooth contact throughout the entire guiding surface of the turbine.

The high speed pinion will be directly connected to the turbine shaft by means of a flexible coupling, so arranged that any actual motion in the gears or pinions will not be transmitted to the turbine shaft. Each wheel will carry a right and left helical gear.

The low speed reduction gear will consist of a large gear wheel driven by two pinions, each pinion being driven through a flexible connection from one of the wheels in the high speed gear casing.

The propeller is 19 feet diameter with the blades set at a pitch of 16 feet. The pitch, however, is adjustable from 15 feet to 17 feet. The propeller hub is made of cast iron fitted to the propeller shaft with a taper and key and held by a forged steel nut. The propeller blades are made of manganese bronze.

Propelling Machinery of the Twin Screw Vessels

In the twin screw vessels the propelling machinery, located amidships, consists of two Curtis turbines driving high and low speed reduction gears, designed to deliver 2,000 shaft horsepower each, at 105 revolutions per minute of the propellers. The total maximum shaft horsepower developed with the revolutions of the propellers not exceeding 109 per minute will be 4,500.

The principal characteristics of the turbines and reduction gears on the twin screw vessels are the same as those for the single screw vessels, as explained above. The propellers, however, are solid, 14 feet 6 inches diameter, made of bronze.

Boilers

On the single screw vessels steam is supplied by three Scotch boilers, each 16 feet 6 inches inside diameter, and 12 feet 3 inches long over the heads, with a heating surface of 3,546 square feet. Each boiler has four Morrison corrugated furnaces, 42 inches inside diameter. The boilers are designed for a pressure of 195 pounds per square inch and work under the heated system of forced draft, for which one Sturtevant multivane blower fan with two engines is located in the engine room. The boilers are arranged to burn fuel oil on the Dahl system, the necessary pumps, filters, heaters, etc., being arranged in the fireroom.

On the twin screw vessels steam will be supplied by four Heine watertube boilers of 15,000 square feet heating surface working under forced draft and burning oil on the Dahl system.

Auxiliaries

The auxiliaries on both the single and twin screw vessels are identical. A main condenser of 5,850 square feet of cooling surface is provided, connected to an air pump of the independent wet and dry twinplex beam type, the necessary cooling water being supplied by a main centrifugal pump of 18 inches diameter directly connected to a 10-inch by 9-inch single cylinder vertical engine.

The necessary pumps, which are of the Blake & Knowles type, the high and low feed water heaters of Griscom-Spencer make, and an auxiliary condenser are located conveniently in the engine room. Abaft of the reduction gear is the thrust bearing, consisting of ten horseshoes with ample wearing surface. The line shafting consists of seven sections with the necessary bearings.

The electric plant consists of two 20-kilowatt General Electric generator sets, driven by reciprocating engines. There is a 2-ton Brunswick refrigerating machine and a Griscom-Spencer evaporating machine of 35 tons capacity.

For handling cargo there are 24 derricks, served by 24 single-drum winches of the Hyde type. The capstan and windlass on the single screw vessels will be supplied by the American Engineering Company, while on the twin screw vessels the capstan and windlass are of the Hyde type. The steering gear is of the Brown tiller type.

The lifeboats are handled under Martin-Freeman davits.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

In What Part of a Scotch Boiler Should the Feed Water be Discharged?

This is a question that the writer has never seen answered. No technical book that he has ever read answers it satisfactorily, and he has never seen any article that discussed this question directly. There has been some incidental reference to it in articles dealing with other questions pertaining to marine boilers, but none that related to this matter entirely. It would seem that this question is of sufficient importance to be a subject for discussion in the columns of the INTERNATIONAL MARINE ENGINEERING.

That boiler designers have different ideas on the subject is very evident from the fact that the feed water discharges in various places in this type of boiler. The usual practice is to have the feed water enter the boiler on the side, with an internal feed pipe to carry it to different places in the boiler, varying according to the ideas of the designer. In some cases it is carried down to the bottom of the boiler under the furnaces. In other cases it is carried up over the tubes to the middle of the boiler and discharged just below the water line. In still other cases the water is carried down between the tubes to some point above the furnaces, the distance varying according to the notion of the designer. In two cases that came under the observation of the writer the feed water entered through the top of the boiler and discharged in the steam space.

Undoubtedly the designers have reasons for the various practices in this matter, but the writer is firmly of the opinion that there can be no good reason for discharging the feed water in the steam space of a boiler, therefore he dismisses this practice without further comment.

It has been demonstrated that the water in a Scotch boiler does not circulate in the bottom unless the fires are forced sufficiently to generate steam to probably one-half the capacity of the boiler, therefore it follows that in raising steam the cold water remains in the bottom of the boiler until steam begins to generate fairly rapidly, a fact with which every marine engineer is familiar; also when the engines are stopped and the fires banked so as to generate only sufficient steam for the auxiliaries the water in this type of boiler cools off in the bottom, showing that circulation has ceased. It would seem to the writer that under these circumstances it would be better practice not to discharge cold water in the bottom, cold water being any water that is below the temperature of the water in the boiler.

On the other hand, when the boiler is working almost up to its capacity, as when the engines are running over half speed, and the water is circulating in the bottom, it does not appear to be good practice to discharge the cold water above the furnaces where it meets the rising globules of steam, necessarily impeding the circulation and probably condensing considerable of the steam that has formed. The writer also believes that many cases of chronic foaming in boilers are caused by this practice. In fact, he cured a battery of three-furnace boilers of this disease by extending the internal feed pipes, which discharged the feed water near the top row of tubes, down to the fire line of the middle furnaces.

It has been demonstrated by placing a thermometer at or near the bottom of a boiler that when the water is circulating properly there is very little difference in the temperature of the water in the bottom from that in the top, even when the feed water is discharged in the bottom, showing that the cold water is immediately carried up by the circulation; therefore the writer believes that the proper place to discharge the main feed in a Scotch boiler is at or near the bottom. Further, he believes that the proper place to discharge the auxiliary feed, which is rarely used except when the engines are stopped and the water not circulating in the bottom, is above the furnaces, preferably about half way up to the top row of tubes. As the United States Inspector's rules require the auxiliary feed to enter the boiler through an opening entirely independent from the main feed, this can easily be done. In former years the almost universal practice was for both feeds to enter the boiler through the same opening and discharge through the same internal feed pipe.

The writer of this article does not claim to be an expert in any sense of the word, simply a practical marine engineer who has had considerable experience with this type of boiler, and who has reasoned this matter out solely from this experience, he having no knowledge of any treatise on the subject by experts. He would be pleased to hear the views of practical engineers and experts on this question.

J. S.

Graphical Determination of Particulars for Spiral Springs

In marine work the formula generally used to determine the size of steel wire for spiral springs having a mean diameter D and subject to a total load W, is:

$$d = 3\sqrt{\frac{D.W.}{c}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where d = diameter of round or size of square steel in inches,
c = 15,000, 11,000, or 8,000, according to shape of section and the requirements to be worked to.

To obtain the number of free coils N, when the above data are known, and the compression C decided upon, it is usual to adopt the notation:

$$C = \frac{N.W.D^3}{d^4 a}, \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where d = size of wire in 1/16 inch.
a = 26 for round (British Admiralty), 22 for Board of Trade.
a = 32 for square (British Admiralty), 30 for Board of Trade.

The several forms of equations 1 and 2 all lend themselves readily to graphical solution and, if plotted to specially selected scales, the graphs take the form of straight lines. To anyone who has a number of springs to design for different duties a graph which will enable him, with a little calculation, to ascertain the particulars re-

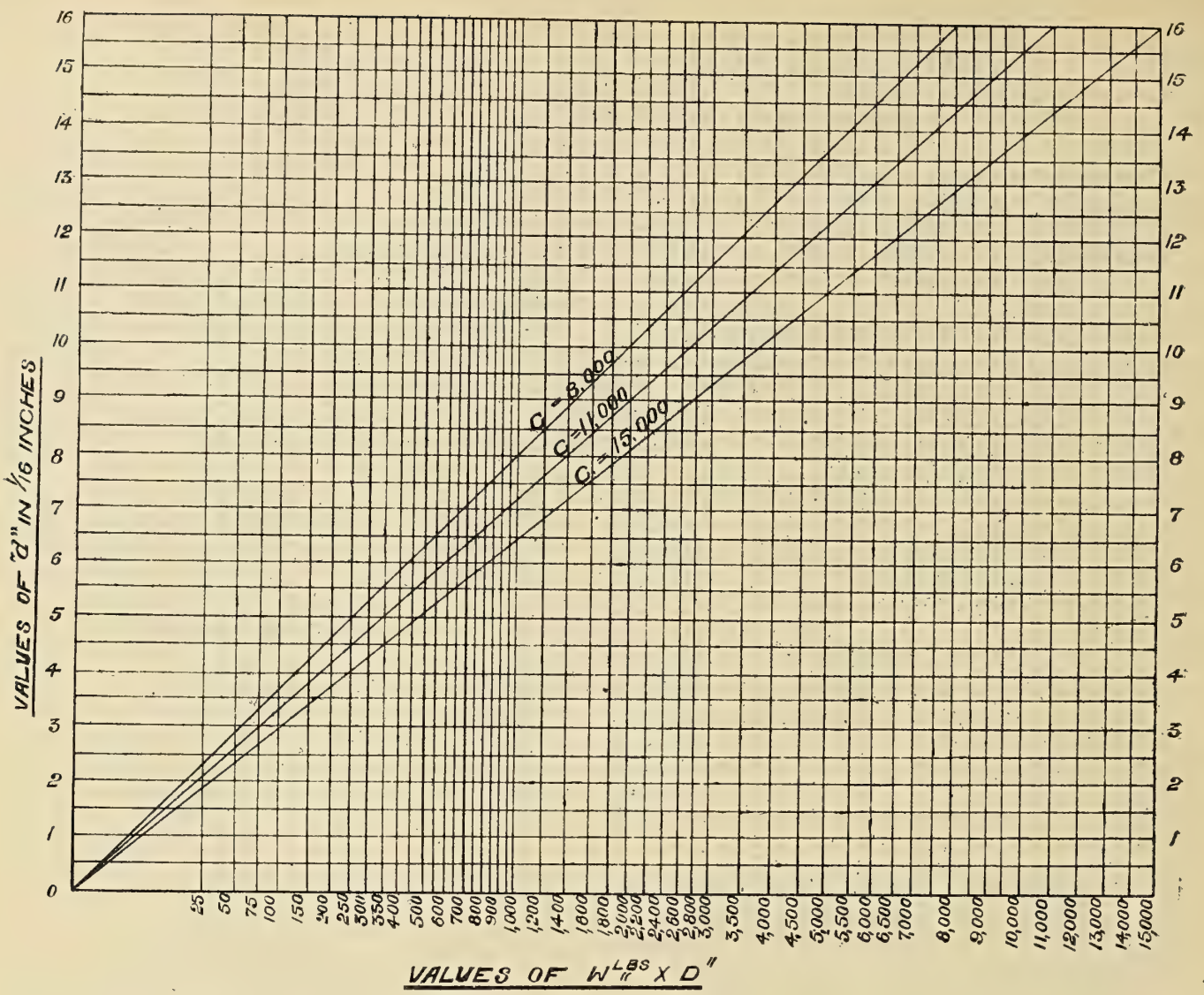


Fig. 1

quired, may be the means of saving much time and trouble. Besides, he is able to see immediately how the alteration to any one quantity will affect the final result without wading through a string of figures.

Fig. 1 gives the relation between d in sixteenths of an inch and $D \times W$ in inches and pounds. By interpolating from the graph the size of wire, given by equation 1, for any of the values of c may be obtained.

Fig. 2 represents the relation between D inches and N/C number of coils per inch of compression for sizes of d from ¼ inch to 1 inch, advancing by one-sixteenth of an inch. This set of curves, however, only covers the equation 2 for one value of a, that of 32. Moreover, since it is constructed on the base of the stress imposed upon the steel by equation 1 it is only correct for the value d where the constant $c = 15{,}000$. Nevertheless, it is quite a simple operation to correct the graph for any value of "c" and "a," all that is necessary being to multiply the number representing $\frac{N}{C}$ from the graph by

$$\frac{15{,}000}{32} \times \frac{a}{c}.$$

A few values of these are given below the graph.

It should be noted that in Fig. 2 the mean diameter D relating to the lines sloping from right to left will be found on the top of the graph, the base being reserved for those pertaining to the curves of an opposite slope.

An example illustrating the use of the curves may serve to elucidate any point which is not quite clear.

It is required to determine the particulars of a safety-valve spring to Board of Trade requirements, the following particulars being known:

Total load on spring	=	1,555 pounds.
Mean diameter of coils	=	2¼ inches.
Compression	=	¾ inch.
Constant c	=	11,000
Constant a	=	30
$W D = 1{,}555 \times 2.25$	=	3,499

From curve $c = 11{,}000$ (Fig. 1) read on line $W D = 3{,}500$ $d = 10.75$ sixteenths of an inch, *i. e.*, $d = 43/64$.

On Fig. 2, where the line of mean diameter 2¼ would cross the line $d = 10.75$, read $\frac{N}{C} = 18.5$ coils.

Therefore, $N = 18.5 \times ¾ \times 1.28 = 13.9$ free coils.

Note that 1.28 is obtained from table below Fig. 2.

It should be borne in mind that since Fig. 2 is constructed on the base of the stress imposed on the steel by Fig. 1, the size obtained from Fig. 1 must be maintained to within 1/64 inch for correct results.

Newcastle-on-Tyne. ARTHUR HOARE.

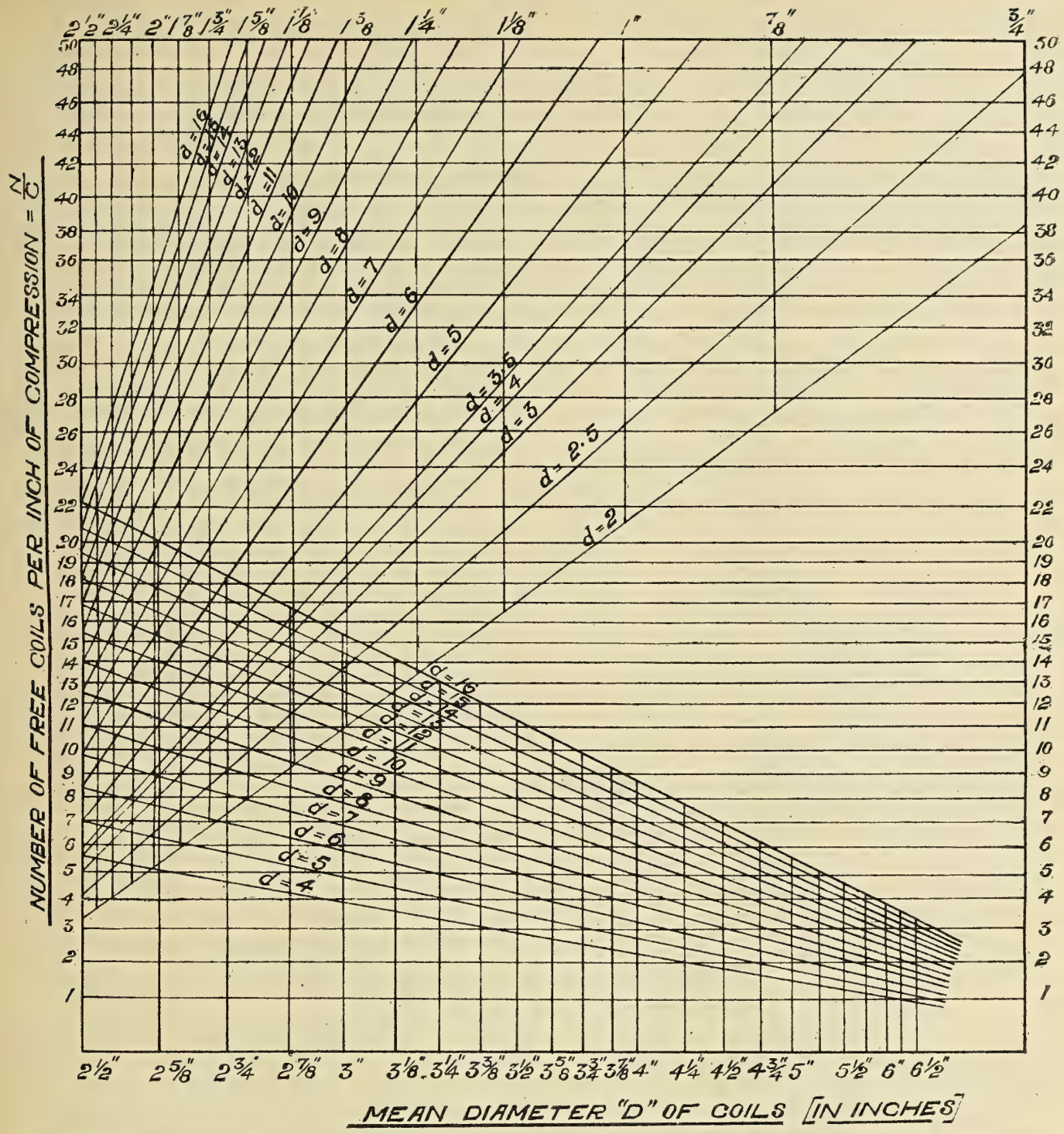


Fig. 2.—Use Curves* Sloping from Right to Left for Mean Diameters up to 2½ Inches, and Those Sloping from Left to Right for Mean Diameters from 2½ to 6½ Inches

* Table of Constants:

Value of C	Value of a	Correct Value of N = N (From Curve) ×
11,000	26	1.11
11,000	30	1.28
11,000	32	1.36
8,000	22	1.29
8,000	26	1.52

Statical Stability at Small Angles

At a very small angle of inclination, the size of the righting area or $G\ Z$ of a ship is given by the expression:

$$G\ Z = G\ M \sin \theta.$$

The theorem of the statical stability of a wall-sided vessel indicates that the height of metacenter above center of buoyancy, or $B\ M$, has a great influence. This theorem is as follows, the figures representing respectively a ship whose sides are vertical all fore and aft and an enlarged representation of the emerged wedge:

Area of triangle $O\ A\ B = ½\ y^2 \tan \theta$.
Lever about vertical $X\ X = O\ F$.
Moment about vertical $X\ X = O\ F \times ½\ y^2 \tan \theta$.
But $O\ F = (O\ E + E\ F)$.
$= (O\ E + A\ C \sin \theta)$.
$= (y \cos \theta + ½\ y \tan \theta \sin \theta)$.
$= \left(y \cos \theta\ (1 + ½\ y \tan \theta) \dfrac{\sin \theta}{\cos \theta} \right)$
$= y \cos \theta\ (1 + ½ \tan^2 \theta)$.
Substituting Moment of Triangle about vertical $X\ X$
$= y \cos \theta\ (1 + ½ \tan^2 \theta) \times ½\ y^2 \tan \theta$.
$= ½\ y^3 \sin \theta\ (1 + ½ \tan^2 \theta)$.

Total moment of emerged and immersed wedges

$$= I \sin\theta\,(1 + \tfrac{1}{2}\tan^2\theta)$$

where I = transverse moment of inertia of waterplane in upright position.

This is = volume $\times B\,R$.

Therefore

$$B\,R = \frac{I}{V}\sin\theta\,(1 + \tfrac{1}{2}\tan^2\theta),$$

$$= B\,M \sin\theta\,(1 + \tfrac{1}{2}\tan^2\theta),$$

and $$G\,Z = B\,M \sin\theta\,(1 + \tfrac{1}{2}\tan^2\theta) - B\,G \sin\theta.$$

$$= \sin\theta\,(B\,M + \frac{B\,M}{2}\tan\theta - B\,G).$$

$$= \sin\theta\,(B\,M + \frac{B\,M}{2}\tan^2\theta)$$

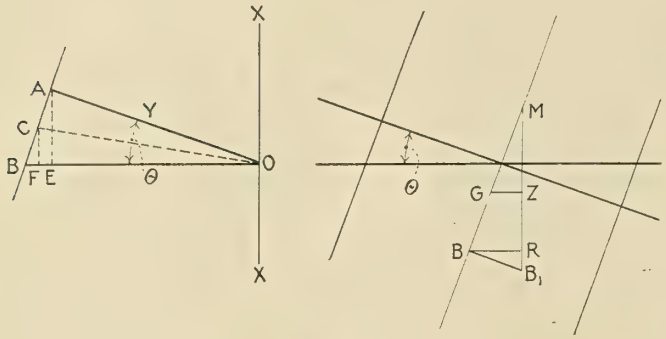


Fig. 1

This expression contains the increase in $G\,Z$ over the value given by $G\,M \sin\theta$; it may be written:

$$G\,Z = G\,M \sin\theta + \frac{B\,M}{2}\tan^2\theta \sin\theta,$$

the latter part being the increase.

Divergence in $G\,Z$'s of actual ships, from the values obtained by this formula is due to the sloping nature of shipshape transverse sections. At small angles, however,

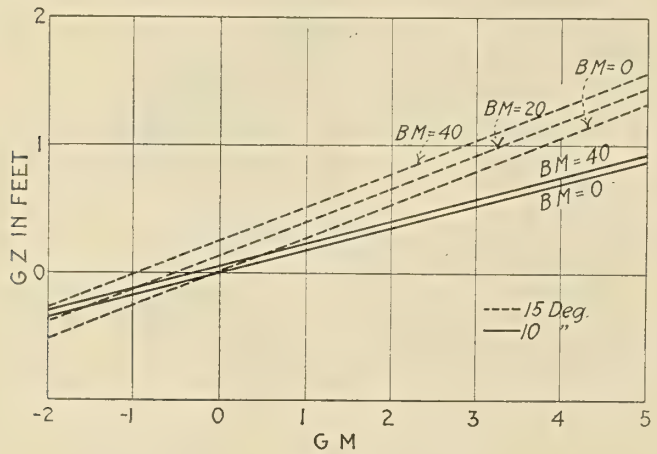


Fig. 2

it is possible to get values for the righting lever of ship forms by the employment of diagrams based on the $G\,M$ and $B\,M$ of the upright position.

Up to an inclination of about 30 degrees, provided the ratio of beam to draft is not abnormally great, and also that the deck edge has not previously entered the water, the diagrams appended will be found to give close approximation to $G\,Z$'s enabling the naval architect to draw the lower end of the statical stability curve. At 10 degrees, 15 degrees, or even 20 degrees, the values are reliable enough to replace the results of the usual lengthy calculations, and the 30-degree lines supply at least a valuable check. It would not have been of any service to give a diagram based on the same factors for 45 degrees, as the deck edge is usually immersed long before this inclination has been reached. The variations in the angles at which this occurs in different ships and the effect of superstructures would obviously make such a diagram useless for practical purposes.

A use to which these diagrams may be put is to predict the angle of heel at which a vessel with a small negative $G\,M$ would lie, assuming no water ballast used to lower "G" and correct this tendency. This sometimes occurs in vessels without coal, cargo, etc., on board, such as liners, where it is desirable to have a small positive

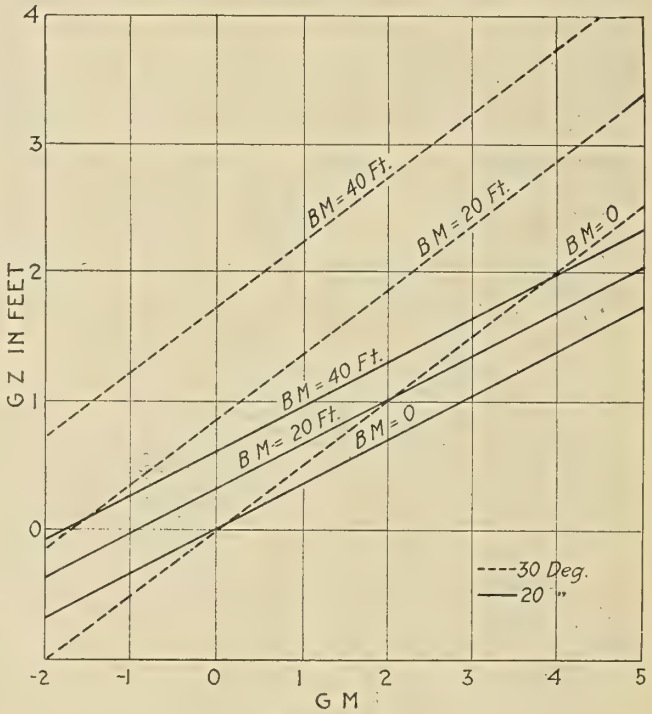


Fig. 3

$G\,M$ with all cargo on board to insure easy rolling, resulting in the necessary adoption of a negative value for the unloaded condition.

An example will illustrate the procedure: A liner has an estimated $G\,M$ of —0.45 feet and $B\,M$ of 16.5 feet

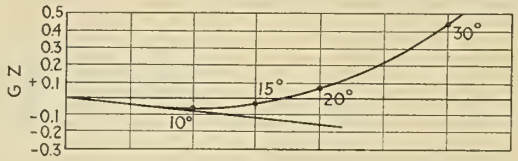


Fig. 4

with no cargo, etc., on board. If the draft has to be kept to a minimum for some purpose, so that water ballast may not be used, to what angle will the vessel "loll"?

From the diagrams the $G\,Z$'s are obtained as tabulated below:

Angle	10°	15°	20°	30°
$G\,Z$.....	—.06	—.03	+.07	+.45

If this is plotted as shown in the figure, it will be seen that at the angle of 17 degrees the $G\,Z$ becomes positive, increasing rapidly in amount and giving the vessel comparatively great stability beyond this angle. PETER DOIG.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Consumption of Lubricating Oil for Gasoline (Petrol) Engine

Q.—What is a reasonable consumption of lubricating oil for a 10-horsepower gasoline (petrol) engine?

A.—A moderate consumption is about 0.008 pint per brake horsepower per hour. This would be about 0.08 pint per hour for the engine cited.

Relative Calorific Values of Gasoline (Petrol) and Kerosene (Paraffin)

Q.—Can you tell me whether the power available in kerosene (paraffin) is equal to that available in gasoline (petrol)? Would I get as much power from my engine if I operated with kerosene (paraffin) as gasoline (petrol)?

A.—The average calorific values of gasoline (petrol) and kerosene (paraffin) are about the same, from 20,000 to 21,000 B. T. U. per pound, with a shade the higher values for gasoline (petrol). If you obtain proper carburetion there should be but little difference in horsepower of output using either.

Type of Turbines on the Vaterland and Imperator

Q.—What is the type of turbines on the steamship *Vaterland* and *Imperator?* G. N.

A.—The turbines of the *Imperator* and *Vaterland* are a combination of the Curtis and Parsons or, more properly stated, of the impulse and reaction types. This is a combination which is now quite common and exists largely from the desirability of avoiding small tip clearances at the high-pressure end. This is fulfilled by first passing the steam through several wheels of the impulse type with an attendant large pressure drop and then continuing the steam on through blading of the Parsons type. In the *Vaterland* and *Imperator,* which are each equipped with four turbines totaling 62,000 shaft horsepower, the two center shafts are equipped with the high-pressure turbines and the wing shafts with the low-pressure turbines. In the high-pressure turbines a Curtis wheel, provided with three or four rims of buckets, is placed in front of the drum; in the intermediate turbines a Curtis wheel, fed directly with boiler steam, is mounted on the drum. The drum blades are reaction buckets.

How to Figure Horsepower of Janney-Williams Motor

Q.—Will you kindly explain how to obtain the horsepower of a machine such as the Janney-Williams motor from the dimensions of the engine? Which part of the hydraulic pressure on the pistons is used for the turning moment? Could you give a diagram of the resolution of forces acting on the inclined structure? Such information would greatly oblige an old subscriber. I. T.

A.—Probably the easiest way of determining the capacity of a given unit is to figure the horsepower that the constant speed shaft can reasonably transmit; for example, the unit which has a constant speed shaft of 1¾ inches is rated to operate at about 625 revolutions per minute, and at this speed a steel shaft of this size usually carries power according to the following formula (Unwin "Machine Design," Part I):

$$d = \sqrt[3]{\frac{63{,}024}{0.196\, f_s}} \quad \sqrt[3]{\frac{HP}{N}},$$

where HP = horsepower transmitted.
N = number of revolutions per miuute.
f_s = greatest safe stress for the material of the shaft.
d = diameter of shaft in inches.

For alternating stress and good steel

$$\sqrt[3]{\frac{63{,}024}{0.196\, f_s}} = 4.4,$$

so that

$$1.75 = 4.40 \sqrt[3]{\frac{HP}{625}}, \text{ and } HP = 39.3,$$

which is about what this unit is rated at.

The inclined plane is essentially a stroke-regulating device for the hydraulic pistons and a force diagram is unnecessary, as for one revolution the load on the pistons multiplied by their stroke is equal to the torque at the radius of the control disk multiplied by its circumference. The constant speed or driving end operates the first set of pistons at total strokes, which are direct functions of the angularity of the control disk and, therefore, neglecting leakage, the quantity of fluid pumped to the second chamber varies in this proportion. As the second set of pistons is arranged with a constant angularity of control disk and, therefore, constant stroke, the varying quantity sent from the first chamber results in revolutions of the driven shaft, which are directly proportional to this quantity.

Horsepower varies as pressure × quantity pumped, therefore, as pressure × revolutions per minute × stroke (for driving end) and as a similar expression for the driven end. For the driven end the *stroke* is constant and for the driving end the *revolutions per minute* are constant, so that the *revolutions per minute* of the driven end are directly proportional to the stroke of the driving end if we assume the same allowable hydraulic pressure for both chambers. The stroke of the driving end is

$S :: D \cos \Theta$ where D = diameter of control disk.
S = stroke.
Θ = angle between disk and shaft.

From the above it is evident that horsepower is proportional to pressure × revolutions per minute × $D \cos \Theta$; so if we assume an allowable pressure (approximately 800 pounds per square inch), revolutions per minute and angle of disk the horsepower transmitted can be computed by taking account of the actual dimensions.

Books on Propeller Design

Q.—Kindly recommend through your queries department some good text book covering design and laying out of marine propellers. E. W. O.

A.—The best books available upon propeller design are "Speed and Power of Ships," by D. W. Taylor, and "The Screw Propeller," by Dyson. These are both elaborate

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

treatises, and are expensive books. The best moderate-priced book is "Propellers," by C. H. Peabody. This is based upon the experimental investigations of Taylor and has an excellent treatment of the general question of powering and propeller design.

Calorific Value of Coal

Q.—Is there any way whereby the calorific value of a coal can be readily determined if I know its chemical analysis? Chief.

A.—The American Society of Mechanical Engineers in their code for boiler testing recommend the following formula:

$$\text{B.T.U. per pound of coal} = 14{,}600\,C + 62{,}000\left(H - \frac{O}{8}\right) + 4{,}000S$$

where C, H, O and S are the proportionate parts by weights of carbon, hydrogen, oxygen and sulphur. Take for example a coal of the following composition (Pocahontas run of mine):

$C = 85.4$ percent. $H = 4.39$ percent. $O = 3.94$ percent. $S = 0.62$ percent.

B. T. U. $= 14{,}600 \times .854 + 62{,}000 \times .039 + 4{,}000 \times .006 = 14{,}912$. As tested by calorimeter this coal had actually a calorific value of 14,906.

Volume of Compressed City Gas for a Tank

Q.—(1) How many thousand cubic feet of city gas would a seamless steel tank 12 inches diameter and 36 inches long contain at a pressure of 500 pounds per square inch?

(2) How many cubic feet of gas will a boiler burn per hour from a grate area of 20 square feet running full blast? T. G.

A.—(1) The characteristic equation for a perfect gas is $PV = RT$, where P = pressure in pounds per square foot, V = volume of 1 pound in cubic feet, T is the absolute temperature (Fahrenheit temperature plus 459.5 degrees) and R is the so-called gas constant, a constant which varies for different gases but which remains the same for a given gas. A reasonable value for R for the average illuminating gas as used in American cities is about 135, so that the equation becomes for this case $PV = 135\,T$. For this problem V is the characteristic desired, P is given as $500 \times 144 = 72{,}000$ pounds per square foot and assuming normal atmosphere temperature of 60 degrees F,

$$T = 60 + 459.5 = 519.5 \text{ degrees.}$$

$$V = \frac{135 \times 519.5}{72{,}000} = .974 \text{ cubic foot.}$$

The volume of the tank is

$$\frac{\pi \times 1^2 \times 3}{4} = 2.36 \text{ cubic feet,}$$

so there could be put into the tank at the pressure given $2.36 \div .974 = 2.42$ pounds, approximately. As supplied in city mains, the gas pressure averages about 1 inch water, which is 5.2 pounds per square foot, so that the pressure under which the gas goes through the meter is $5.2 + 14.7 \times 144 = 2{,}120$ *pounds per square foot.* The specific volume at this condition and at a temperature of 50 degrees Fahrenheit (as the mains are usually cooler than the supply tank) is

$$V = \frac{135 \times 510}{2{,}120} = 32.5 \text{ cubic feet.}$$

The total amount drawn through the meter and stored in the tank will, therefore, be

$$32.5 \times 2.42 = 78.6 \text{ cubic feet.}$$

(2) The estimate should preferably be made using the heating surface of the boiler instead of the grate surface, but an approximate determination can be made as follows: If we assume that the boiler could be forced to a combustion of 25 pounds of coal per square foot of grate per hour using coal of a calorific value of 14,000 B.T.U. per pound, we would have generated $25 \times 14{,}000 \times 20 = 7{,}000{,}000$ B.T.U. per hour over the entire grate. Ordinary illuminating gas has a calorific value of about 550 B.T.U. per cubic foot, so there would be necessary $7{,}000{,}000 \div 550 = 12{,}750$ cubic feet per hour to give the equivalent heat.

Horsepower of Stern-Wheel River Boats in Up Stream and Down Stream Runs

Q.—It is noted with our stern-wheel, shallowdraft river boats, that when running up stream the revolutions per minute of the engine are greater than when running with the current; cut-off, steam pressure, position of throttle, depth of water, and, in fact, all conditions being the same. Indicator cards taken when running up and down stream show same area and mean effective pressure. As the revolutions per minute are more up stream than down, what connection should be applied to the revolutions per minute when working out indicated horsepower. It is evident that the indicated horsepower is really the same, but on using the revolutions per minute, which are different in each case, the indicated horsepower computed will, of course, be different. In the case of cards taken up stream only, how can one determine the actual indicated horsepower?

In working out slip (actual), $S = \frac{PR - (V - .2\,V)}{PR}$, should the mean speed and mean revolutions per minute up stream and down stream be used? W. M. M.

A.—The indicated horsepower is the product of the piston speed by the mean effective pressure and by the piston area, all divided by 33,000, and it is essential that the revolutions per minute existing at the time the indicator diagram was taken be used in the computation, so there should be no correction for revolutions per minute applied as you suggest. If the revolutions per minute are greater up stream than down with engine conditions the same, it may be due to difference in hull conditions, such as less cargo, or possibly current condition; but in any case the correct procedure is to take the revolutions per minute which existed at the time the diagrams were taken for computing the indicated horsepower. You will very likely find that though the revolutions per minute may increase the mean effective pressure from the cards will decrease so the resultant indicated horsepower will be but little different.

As to slip, it would be preferable to work out the slip independently for the two conditions, for the same reason as above stated. The formula which you quote for real slip assumes a 20 percent wake, which is only an approximation, though it probably treats both conditions alike. The fundamental relationship between real and apparent slip is as follows:

when S is real slip
S' is apparent slip
w is wake
v is speed of ship, feet per minute
P is pitch of propeller (πD for stern wheelers)
R is revolutions per minute

$$S' = \frac{PR - v}{PR}$$

$$1 - S = (1 - S')\,(1 - w)$$

Substituting the value of apparent slip and reducing we get

$$S = \frac{PR - (v - wv)}{PR}$$

which is the same as that quoted if we assume a 20 percent wake.

Argentine Battleships Accepted.—After satisfactorily fulfilling a guarantee of one year's active service the battleships *Rivadavia* and *Moreno,* which were built in the United States, have been accepted by the Argentine Government. The *Rivadavia* was built by the Fore River Shipbuilding Corporation, Quincy, Mass., and the *Moreno* by the New York Shipbuilding Company, Camden, N. J.

Shipbuilding and General Marine News

**Contracts for New Ships—Marine Terminal Improvements—
Recent Launchings — Improved Appliances — Personal Items**

Definite announcement has been made that the Bethlehem Steel Company will soon authorize the expenditure of from $15,000,000 (£3,080,000) to $20,000,000 (£4,100,000) for the extension of the newly acquired plant of the Maryland Steel Company at Sparrows Point, Md. That the shipbuilding facilities of the Maryland Steel Company will be greatly enlarged seems certain in view of the present condition of the market for new vessels.

Closely following the announcement made last month of the acquisition by the New York Shipbuilding Company and the Newport News Shipbuilding & Dry Dock Company of the rights to manufacture in the United States the Werkspoor type of Diesel engine, the announcement is now made that the William Cramp & Sons Ship & Engine Building Company has acquired the exclusive rights in this country for the manufacture of the Burmeister & Wain Diesel engine for marine purposes. With the three largest shipyards in the country equipped for the building of large motor ships and with over twelve other firms either already engaged or about to begin the manufacture of heavy oil engines for installation in marine vessels, it is very apparent that the era of the motor ship is safely launched in the United States.

Contracts for New Ships

The Seattle Construction & Dry Dock Company, Seattle, Wash., has received a contract from the Luckenbach Steamship Company for the construction of a 10,000-ton freight steamer to be fitted with geared turbo electric propelling machinery. The vessel is to be delivered in seventeen months.

W. R. Grace & Co., New York, have placed an order for two more steamships with the Wm. Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa. Presumably these ships will be 6,300 gross tons, as are the two already under contract with the Cramp Company.

The Coastwise Transportation Company, Boston, Mass., has placed contracts with the New York Shipbuilding Company, Camden, N. J,, for two colliers. This order is in addition to two ships already under contract in the same yard.

The Pittsburg Steamship Company, Cleveland, Ohio, has ordered two of the largest size lake carriers from the American Shipbuilding Company, Cleveland, Ohio.

The Western Dry Dock & Shipbuilding Company, Port Arthur, Ont., has received contracts for the construction of two ocean-going freight steamships.

The Union Iron Works, San Francisco, Cal., has received a contract to build two oil tankers 435 feet long for the Atlantic Refining Company, Point Breeze, Philadelphia, Pa.

The New York Shipbuilding Company, Camden, N. J., has received a contract from the Darrow-Mann Company, Boston, Mass., to build a collier of 9,000 tons carrying capacity.

The Toledo Shipbuilding Company, Toledo, Ohio, will build four steamers for Norwegian owners.

The Maryland Steel Company, Sparrows Point, Md., has received a contract from Captain Christoffer Hannevig, care of Hannevig & Johnsen, New York, to build a 4,000-ton freight steamship. Captain Hannevig is general manager of the Trans-Atlantic Motor Ship Company, Ltd., Christiania, Norway.

The Maryland Steel Company, Sparrows Point, Md., will build two ore steamers for the Pennsylvania Steel Company, Philadelphia, Pa.

The Texas Company, New York, has ordered plates for the construction of four 10,000-ton oil tank steamships to be built at the yard of the Arthur Sewell Shipbuilding Company, Bath, Maine, which was recently leased by the Texas Company.

The Bath Iron Works, Bath, Maine, has received a contract to build a 240-foot steam yacht for John N. Willys, president of the Willys-Overland Company, Toledo, Ohio. This yacht has been designed by Cox & Stevens, New York.

The St. Helens Shipbuilding Company, St. Helens, Ore., will build a three-masted wooden schooner, to be equipped with oil engines, for Captain William Wrightson, of the Kirby Lumber Company, Mobile, Ala.

The McKay Shipbuilding Company, East Boston, Mass., will build a 218-foot wooden passenger steamboat for the Nantasket Steamboat Company, Boston, Mass.

The Clinton Shipbuilding & Repair Company, Philadelphia, Pa., is building a steel hull floating derrick for the Newton Supply Company, Philadelphia, Pa.

The Townsend Marine Railway Company, Boothbay Harbor, Maine, was the lowest bidder for the construction of a single-screw wooden steamer to be built for the Department of Fisheries, Washintgon, D. C.

The American Shipbuilding Company, Cleveland, Ohio, has received contracts from Norwegian companies to build seven steamships for use in the coasting trade abroad.

The Manitowoc Shipbuilding Company, Manitowoc, Wis., has received a contract to build six ships of Welland Canal size for Norwegian owners.

It is reported that the Chester Shipbuilding Company, Chester, Pa., has closed contracts to build six additional steamers, thus giving it orders for a total of eight vessels.

The Seattle Shipbuilding & Dry Dock Company, Seattle, Wash., has received contracts from foreign companies to build three steel freight ships of about 7,500 tons capacity each.

The Great Lakes Engineering Works, Detroit, Mich., has received a contract from the Buffalo Steamship Company, Buffalo, N. Y., to build an ore steamship of 12,000 tons carrying capacity.

The Union Iron Works, San Francisco, Cal., has received contracts from Norwegian companies to build two oil tank steamships capable of carrying 80,000 gallons each. This makes nineteen steamers now building or under contract at the yard of the Union Iron Works.

The Tampa Foundry & Machine Company, Tampa, Fla., has received a contract from the Central Hudson Steamboat Company, Newburgh, N. Y., to build a steamboat 215 feet long, with 48 feet beam.

Cobb, Butler & Company, Rockland, Maine, has received a contract from the Boston Sand & Gravel Company, Boston, Mass., to build a 185-foot steam lighter.

Owen Lantz, Gloucester, Mass., will build a 108-foot oil-engined fishing boat for John Chisholm & Son, Gloucester.

Crowell & Thurlow, Boston, Mass., are contemplating placing orders for two more steamers.

It is reported that the Moore & Scott Shipbuilding Company, San Francisco, Cal., has taken contracts for two more steamers.

Charles Parkhurst & Son, Gloucester, Mass., are building a 92-foot wooden fishing steamer for Captain John Seavey.

William H. Baldwin, New Baltimore, N. Y., is building a 75-foot wooden tug for Captain Hawley, of New Baltimore.

The Mathis Yacht Building Company, Camden, N. J., is building a 120-foot wooden passenger boat to be propelled by two 150-horsepower Diesel oil engines.

Three coastwise steamers owned by the Boston & Virginia Steamship Company are to be converted into tank steamers for transporting oil in bulk. Each vessel will be lengthened about 50 feet.

The Moore & Scott Iron Works, San Francisco, Cal., has received a contract from G. W. McNear, New York, for the construction of a steel steamer 379 feet long by 52 feet beam of 7,200 tons deadweight carrying capacity.

Contracts Pending

Contracts are pending for building twenty-five to thirty steamships, the delay being due to difficulty in securing steel deliveries.

J. W. Millard & Bro., New York, have made designs for a 215-foot, steel-hull freight and passenger steamship for Hudson River service.

The Navy Department, Washington, D. C., opened bids on February 16 for the construction of two seagoing submarines.

Cox & Stevens, 15 William street, New York, are preparing designs for a 260-foot steam yacht for C. K. G. Billings, 30 East Forty-second street, New York.

The Gaston Williams & Wigmore Steamship Company has been incorporated at Wilmington, Del., with an authorized capitalization of $5,000,000. The head offices of the company are 140 Broadway, New York. The company is organized to own and build vessels for use in foreign trade, particularly the Far East. The company already owns several vessels and is in the market to purchase or build more.

Shipyard Changes and Improvements

The Maryland Steel Company, Sparrows Point, Md., has become a subsidiary of the Bethlehem Steel Corporation and an immediate expansion of its shipbuilding facilities is expected.

Charles M. Schwab, of the Bethlehem Steel Works, South Bethlehem, Pa., has purchased the plant of the United Engineering Works at Alameda, Cal. Extensive improvements are planned, including building slips where large merchant vessels can be laid down. The yard will be operated as part of the Union Iron Works, San Francisco.

Captain Christoffer Hannevig, care of Hannevig & Johnsen, 80 Broad street, New York, is reported to have bought the shipyard of the Pusey & Jones Company, Wilmington, Del., and it is understood that he is going to use the yard for building schooners, fitted with either steam or oil engines.

Samuel L. Moore & Sons Corporation, Elizabeth, N. J., which has taken over the old Crescent Shipyard, has placed a contract for its new foundry building, and will shortly be in the market for machinery.

The Anderson Steamboat Company, Seattle, Wash., will construct a floating dry dock and enlarge its shipbuilding yards at an estimated cost of $500,000 (£102,500).

D. E. Skinner and C. B. Kamont have organized the Skinner & Eddy Shipbuilding Corporation at Seattle, Wash., and it is reported that the construction of two freight steamers will be begun at an early date.

Johnson & Lanteri, Pittsburg, Cal., contemplate adding to their shipyard a marine railway to have a hauling-out capacity of 2,500 tons. This firm also contemplates enlarging its plant so as to build steel hulls.

It is reported that the Scottish-Mexican Oil Company, 50 Broad street, New York, has taken over the old Marvel Shipbuilding yard at Newburgh, N. Y., and will build a number of oil barges.

The Northern Transportation Company, of Baltimore, Md., has been incorporated in the State of Delaware, with a capital stock of $1,500,000 (£308,000), to construct and operate steamers of all kinds. The incorporators are John T. Donohue, John T. Donohue, Jr., Thomas J. Donohue and Wm. L. Donohue, all of Baltimore.

The Tank Shipbuilding Corporation has been incorporated in New York, with a capital stock of $800,000 (£164,000), to engage in building ships. The incorporators are P. A. Walter, J. G. Deane and H. W. Acton, 120 Broadway, New York.

Burmeister & Wain Diesel Motor to be Built in America by the William Cramp & Sons Ship and Engine Building Company

It will be of interest to shipowners to learn that the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., has recently acquired from Messrs. Burmeister & Wain, of Copenhagen, Denmark, the rights to build the Burmeister & Wain Diesel marine motor in the United States. The Danish company has been phenomenally successful with this engine, specializing principally on cargo and semi-cargo boats. The *Chile,* which was completed in December last, makes the eighteenth vessel turned out complete by the parent company alone. This, however, does not comprise their total motor output from their engine works. They have orders in hand at present for vessels sufficient to keep them occupied for six years with their present facilities, which provide for the construction of not less than one vessel every two months.

In Great Britain the business is being handled by the Burmeister & Wain (Diesel System) Oil Engine Company, Ltd., in which Lord Pirrie, of Harland & Wolff, is the guiding spirit. Their shops, located in Glasgow, have been laid out with the purpose of manufacturing these engines exclusively. They have already completed the main and auxiliary engines for their sixth vessel, as well as many auxiliary emergency sets for driving dynamos. In addition to the above, they have either under construction or on order engines amounting to over 50,000 indicated horsepower.

The first motor ship in England to be fitted with Burmeister & Wain engines was constructed by Messrs. Barclay & Curle. This was the *Jutlandia,* sister ship of the Copenhagen firm's famous first ship *Selandia,* which was completed just four years ago.

In Norway the licensee is Akers Yard, of Christiania, who have completed their third vessel, and in Sweden Goteborg Nya Verkstadsktiebolog, of Goteborg, who have two vessels to their credit. In Belgium, John Cockrill have the rights and had under construction the engines for one ship when the war broke out.

The following list of shipowners who have ships built, building, or on order, equipped with Burmeister & Wain engines, shows the wide acceptance of this Diesel motor

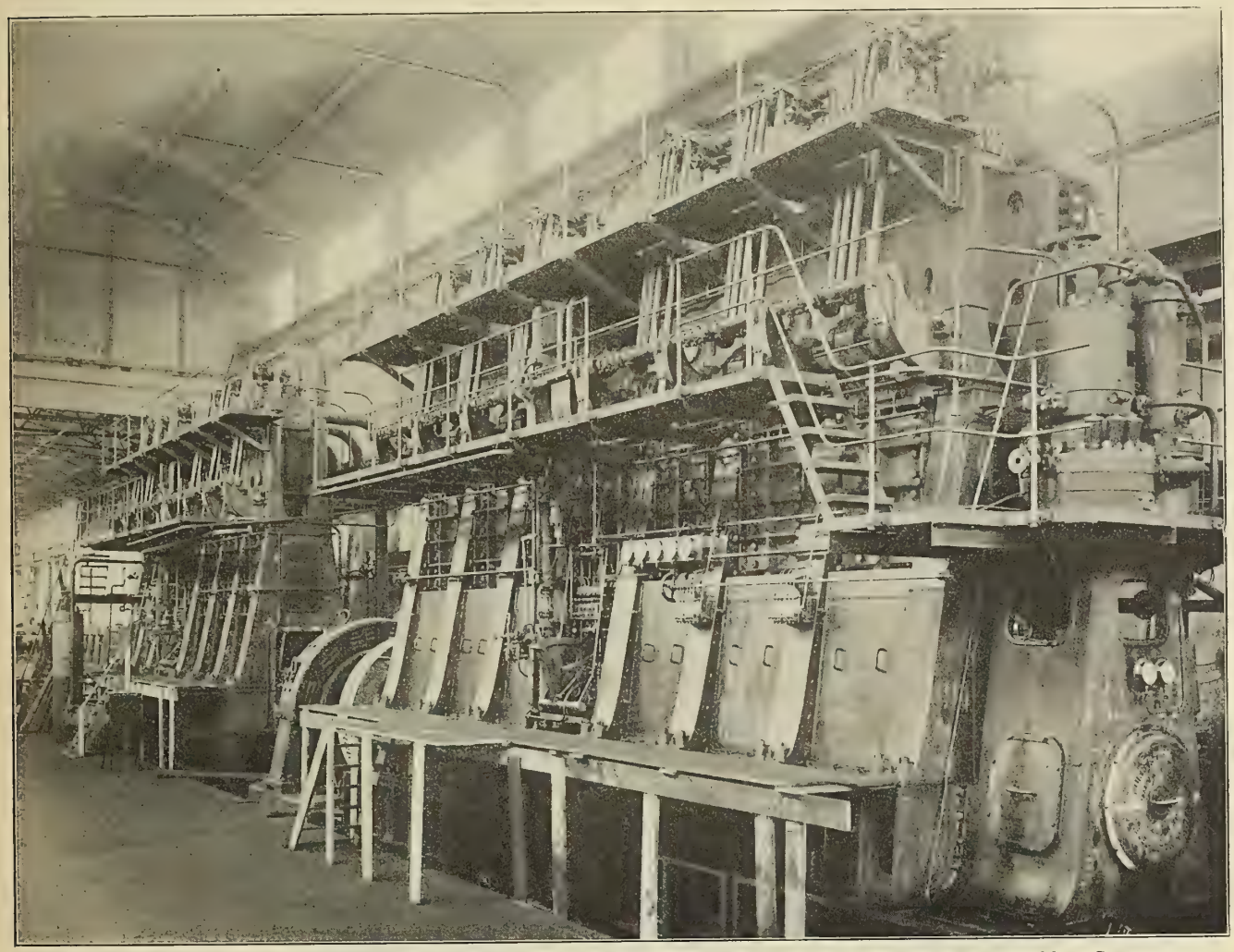
on the other side of the Atlantic: The East Asiatic Company, the Hamburg American Company, the United Steamship Company, the Nordstjernan, the Atlantic Transport Company, the Western Australian Government, Fred Olsen & Co., Elder, Dempster & Co., the Pacific Steam Navigation Company, Frederick Leyland & Co. and Alex. Brostrom & Son.

Burmeister & Wain have within the last year taken up the construction of motors for submarines. These motors are a natural development of their well tried out line of small motors for driving dynamos and compressors.

In a paper read by Mr. I. Knudsen, engineer director of Burmeister & Wain, in July, 1914, before the Northern Merchants Shipping Association at Malmo, Sweden, it was shown, from vessels then in operation and owned by the East Asiatic Company, that a saving of 67 percent in operation was then being effected with the motor ships over the steam-driven vessels owned by the same company. From experience gained with this motor by the East Asiatic Company, they are not only having all new vessels equipped with motors, but are replacing all steam installations in existing vessels with motors.

The Burmeister & Wain Company has never advocated the two cycle engine, having always been firm believers in the four cycle principle from the standpoint of utmost reliability and economy. They have also been conservative in the development of their motors, and have made no large changes at any one time. This is illustrated in the cylinder sizes. There were eight cylinders per engine in the *Selandia* of 21.2 inches diameter by 29.2 inches stroke, with about 160 indicated horsepower per cylinder. This led to building an engine of the same power in six cylinders, which number is now used for all powers. The largest cylinder so far built is 29.6 inches by 44 inches, which gives about 340 indicated horsepower per cylinder, or 4,000 indicated horsepower per ship with twin screws operating at 100 revolutions per minute.

Another development of the engine is the casting of the cylinders in blocks of three, which is an improvement over the earlier design where the cylinders were cast separately. With the new design it is claimed that there is no danger of cracked cylinders, as liners are fitted of special grade cast iron similar to the heads of pistons.



Burmeister & Wain Diesel Engines of the Type to Be Built by the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa.

Six "A" frames support the cylinders, and to these are bolted the crosshead guides. These frames are furnished with through strain bolts on either side, which pass from the top of the cylinders to the underside of the bed plate at the bearings. This, it is claimed, eliminates the dangers of broken frames and gives great rigidity.

In the earlier designs the pistons and piston rods were made much longer and were well oil cooled. The pistons are now made only sufficiently long to contain the rings and are cooled with sea water like the cylinders.

The bed plates were first of the box type which made heavy and complicated castings. These are now of the plain open type with sheet metal oil pans fitted.

The new designs show the air compressors self-contained and operated from the end of the crank shafts. In

the earlier engines the first compression up to 300 pounds pressure, at which the air-starting flasks are charged, was done by an outside compressor, there being two in number, one a standby driven off the same engines driving the two dynamos. With the newer arrangement no detached compressor is required, although one driven by an electric motor is installed for use if much maneuvering is to be done. This arrangement of air compressors driven from the main engines, it is claimed, makes for greater reliability. Each is of sufficient capacity to serve both engines in case of the breakdown of one. This also permits of three high speed engines, driving dynamos only, being used instead of two slower speed heavy engines driving compressors and dynamos combined.

Experience of the company has shown that electric motor-driven auxiliaries are more suitable for motor boats and accordingly the newest vessels have cargo winches, steering gear, ballast pumps, bilge pumps, etc., motor driven. One of the three generator sets is kept as a standby, two being sufficient for operating all winches and for electric lighting when in port.

A small oil-fired boiler is installed for heating purposes and for operating a small steam-driven emergency air compressor for filling an air flask should there for any reason be no air pressure on any of the flasks. A small hot bulb engine driving a generator is also usually included in the auxiliaries for use when the ship is lying in harbor and the other auxiliaries are not working.

The illustration shows one of the company's latest and most popular sizes of engines, having 1,550 indicated horsepower per engine or 3,100 indicated horsepower per vessel.

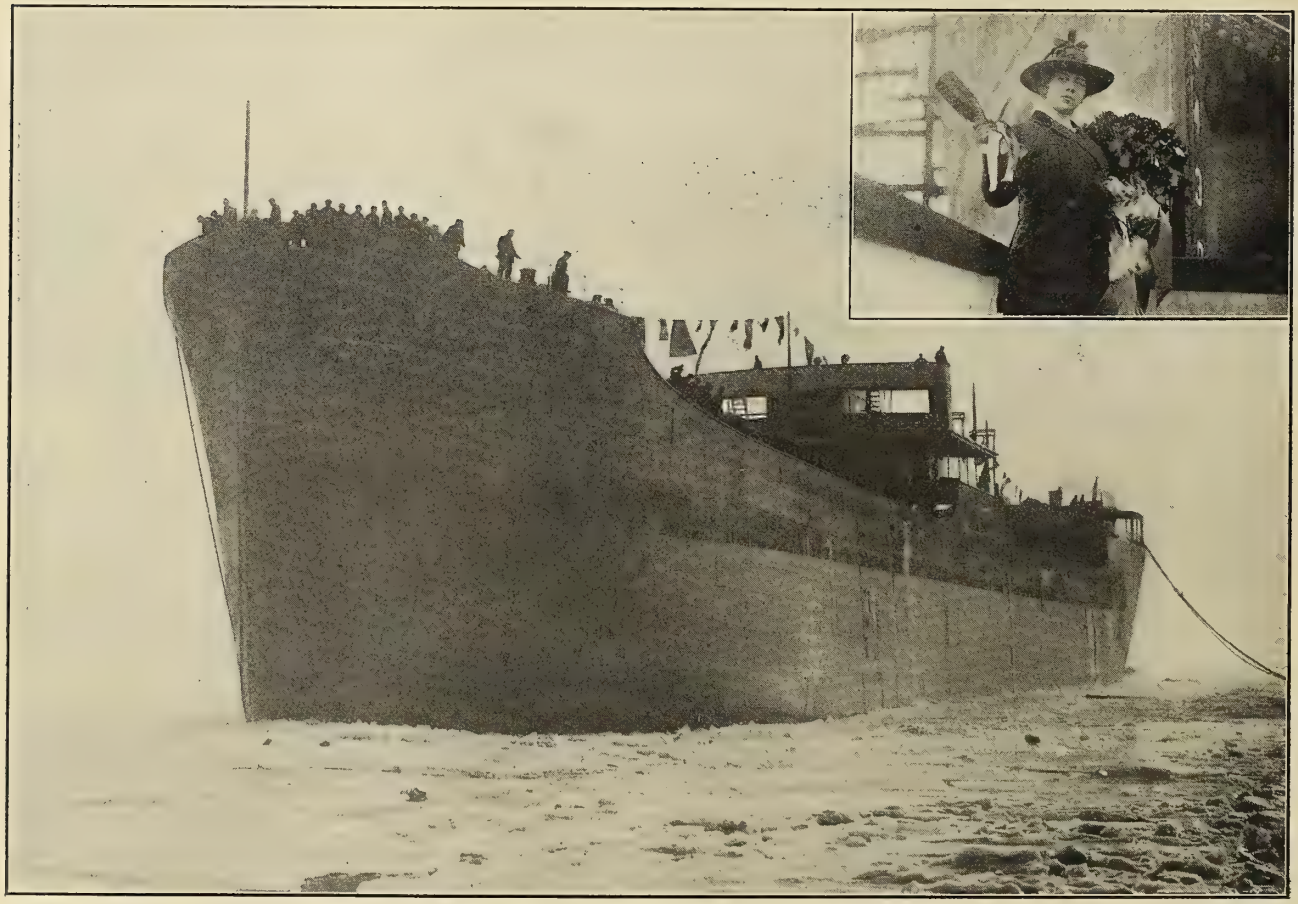
The cam shaft is placed low down and actuated by a chain of gears from the crank shaft. Side by side ahead and astern cams are provided which are brought into play for ahead or astern motion by moving the shaft in a longitudinal direction. The rollers are attached to connecting rods which actuate the rocker arms and are lifted from the cams by means of a layshaft. This is clearly shown in the illustration.

Recent Launchings

The new hospital boat of the St. John Guild, New York, which was described in our February issue, was launched on February 5 at the Jackson & Sharp plant of the American Car & Foundry Company, Wilmington, Del. The vessel was christened by Mrs. John S. Rogers, niece of the donor of the boat, Mrs. A. D. Juilliard.

The passenger and freight steamship *Jalisco,* built for the Mexican Navigation Company for service between New York and the ports in the Gulf of Mexico, was launched on February 7 at the yards of the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa. Miss Mary Kerbin Rowan christened the ship. The *Jalisco* is the first of two vessels being built for the Mexican Navigation Company. Each vessel will be 317 feet long overall, 45 feet beam and 22 feet depth of hold. Accommodations will be provided for fifty first class passengers.

The oil tanker *New York,* sister ship of the *Texas,* described in our February issue, was launched from the yards of the Fore River Shipbuilding Corporation, Quincy, Mass., on February 19. The vessel was christened by Miss Elizabeth Giezendanner, of Houston, Texas. The *New York* is 431 feet 10 inches long overall, 56 feet beam with a carrying capacity of 2,500,000 gallons of oil.



Launch of the Texas Company's New Oil Tanker *New York.* Insert Shows the Vessel's Sponsor

New York Branch of the American Society of Marine Draftsmen Holds Its First Annual Banquet

Over one hundred and twenty-five members and guests of the New York Branch of the American Society of Marine Draftsmen assembled at the Hotel Breslin, New York City, on Saturday evening, February 19, for the first annual banquet of this branch of the society. Mr. P. R. Hichborn officiated as toastmaster, calling attention to the fact that the training and education of marine draftsmen are on a plane with that of other professional men and that the marine draftsmen should be better known and recognized as professional men and receive the compensation commensurate with their standing as professional men. He pointed out several glaring examples of injustices to the marine draftsmen employed in government service. In the first place, the Workman's Liability Act takes no account whatever of the draftsman. While the humble riveter in the yard is protected by the government in cases of accident, no such protecting arm is extended to the draftsman, although he may be exposed to as great dangers in the performance of his duties on the vessels or in the yard. Other injustices pointed out were the lack of an effective system of promotion and retirement in the navy yards and the inadequate compensation given for increased experience on the part of the draftsman. It was pointed out that when in emergencies applicants for positions as ship draftsmen are not required to pass an examination, the chief draftsman should have the right to pass upon the fitness of such applicants.

Among the other after-dinner speakers were Naval Constructor J. D. Bailey, U. S. N.; Lieutenant Commander Earl P. Jessop, U. S. N.; Commander S. H. R. Doyle, U. S. N., senior engineer officer of the battleship *Arizona,* and Honorable Joseph B. Flynn of Brooklyn, member of Congress. Congressman Flynn stated that the pay of government draftsmen was about 25 percent less than that of draftsmen in private establishments. He assured the draftsmen, however, that the matter of increased compensation is impending before Congress and that some recognition is certain to be given.



Banquet of New York Branch of American Society of Marine Draftsmen, Hotel Breslin, New York, February 19

PERSONAL MENTION

Martin C. Bronk, erecting engineer for the United States Government, has been appointed chief engineer of the tug *Colonel Thayer,* at Keyport, N. J.

James H. Allen, captain of the Government tug *Colonel Thayer,* at Keyport, N. J., and one of the best-known river men on the Hudson River, died suddenly on January 21.

Thomas Fogarty, a retired marine engineer, formerly on the Troy (N. Y.) ferries, has purchased a hotel at Saratoga Springs, N. Y.

William Schiler, oiler on the steamer *Iroquois,* of the Manhattan Line, New York, has been promoted as first assistant engineer of the steamer *Mohawk,* of the Manhattan Line.

Charles Hundley has been appointed chief engineer of the river steamer *Slack Barrett,* which recently left Cincinnati, Ohio, for Portsmouth, Ohio, in command of Captain J. H. Brown. George Watson is first assistant engineer of this steamer.

Jesse Allen is chief engineer of the river towboat *Crown Hill,* which recently left Cincinnati, Ohio, commanded by Captain Charles Cole, for the Guyan River for a tow of timber. Charles Harris is first assistant engineer of the vessel.

Captain W. M. Hart, of West Roxbury, Mass., will command the coastwise steam collier *Bristol,* just completed by the New York Shipbuilding Company, Camden, N. J. Captain Hart was formerly in command of the Boston-owned steamer *Norfolk,* engaged in the coal trade between Chesapeake Bay and New England ports.

Captain Thomas V. Kelly, employed by the Erie Railroad Company as master of harbor craft, died from heart disease in Brooklyn on January 18, aged sixty-seven years.

William B. Ruggles, for more than twenty years a prominent engineer in New York and recently engineering adviser to the Russian government, died recently of pneumonia, at his home in Bergen Point, N. J., aged fifty-five. Mr. Ruggles was the founder and head of the Ruggles-Coles Engineering Company, New York.

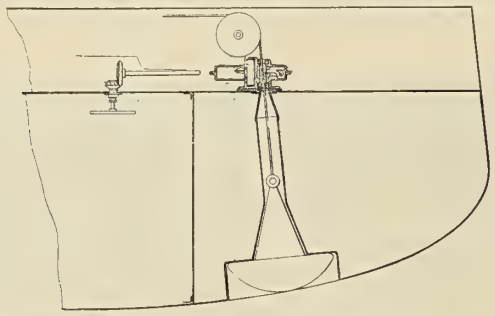
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,158,160. ANCHOR CABLE-CUTTING APPARATUS FOR SUBMARINE BOATS. JOSEPH BARRAJA-FRAUENFELDER, OF BRIDGEPORT, CONN., ASSIGNOR TO THE LAKE TORPEDO BOAT COMPANY OF MAINE, OF BRIDGEPORT, CONN., A CORPORATION OF MAINE.

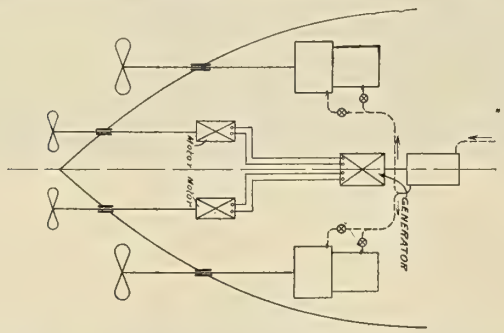
Claim 3.—In combination with a submarine boat, provided with a superstructure and having an anchor well in the main hull thereof; an anchor weight normally housed within said well, and an anchor cable connected to said weight and extending from said superstructure, of an



apparatus for cutting said cable, said apparatus comprising a fixed and a movable cutting blade, means operable from within the boat for actuating said movable blade, and a protecting casing or housing for said cutting blades. Eight claims.

1,158,617. SHIP PROPULSION. HEINRICH ZOELLY, OF ZURICH, SWITZERLAND, ASSIGNOR TO ESCHER, WYSS & CO., A CORPORATION OF SWITZERLAND.

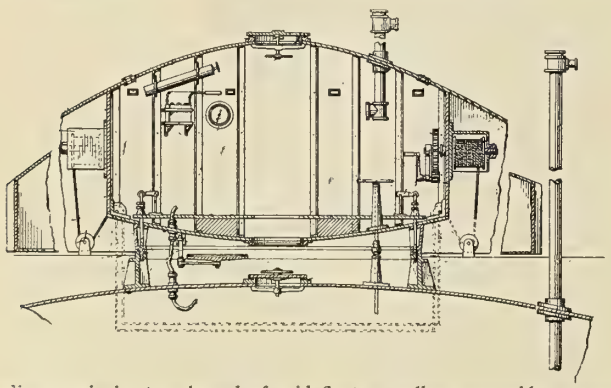
Claim 10.—In combination with a ship, a dynamo turbine and direct-connected dynamo, a propeller shaft, an electric motor connected to said dynamo for driving said shaft, a second propeller shaft and a multi-



stage propeller turbine, direct connected thereto, means for delivering exhaust steam from said dynamo turbine to a higher pressure stage of said propeller turbine when the ship is running at cruising speed than when running at full speed. Ten claims.

1,159,683. SAFETY FLOAT FOR SUBMARINES. HENRY E. KELLER AND HARRY M. SIEDSCHLAG, OF THE UNITED STATES NAVY.

Claim 6.—The combination with a submarine, of a float attachable thereto and releasable therefrom, means operable from within said float for controlling separation thereof from said submarine, said means in-

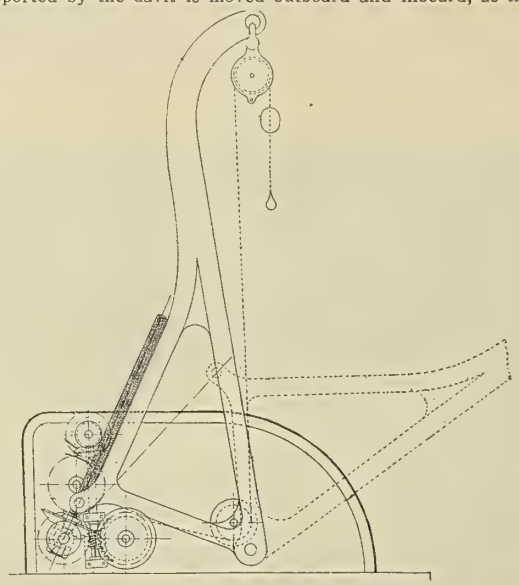


cluding a winch at each end of said float, a pulley removably mounted at each end of said float, flexible connections extending from each winch for training over the adjacent pulley subsequent to an intermediate connection with said submarine, means for removably securing the free extremity of each of said flexible connections to the opposite end of said float, and means for disconnecting either or both of said pulleys in permitting the flexible connections from the corresponding winch or winches to extend through to opposite ends of the float. Ten claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn place, W. C., London.

20,965 OF 1914. SHIPS' DAVITS. G. TURNBULL, 53 DEVONSHIRE ROAD, BIRKENHEAD, CHESTER.

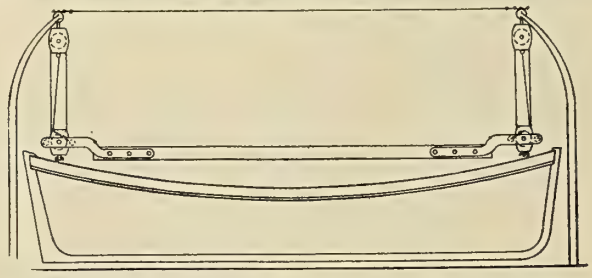
This invention has reference to ships' davits of that kind which is of bell crank lever or triangular form at the lower portion, and is hinged at the outer lower part of the triangle or bell crank portion and is moved about this pivot or hinge by screw and nut gearing, and when worked, the boat supported by the davit is moved outboard and inboard, as the case



may be; and the object of the invention is to provide davits and a mode of operating them, of this kind, which is simple and convenient and can be readily operated.

20,699/14. APPARATUS FOR RAISING AND LOWERING SHIPS' BOATS. H. HUGHES, OF 3, HAZEL ROAD, BIRKENHEAD, CHESHIRE.

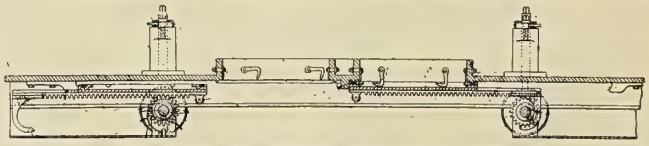
This invention relates to that type of raising and lowering apparatus for ships' boats in which the boat is suspended from the respective davit heads by fore-and-aft gear comprising a block fixed to the davit head and a block connected by disengaging gear with the boat, the invention



having reference more particularly to that type of such gear in which the two lower blocks are connected together by a fore-and-aft spar, whereby the bottom sheave blocks when disengaged from the boats, are prevented from rotating about vertical axes and thus twisting the tackles, and also from tumbling over about horizontal axes and thereby jamming the ropes in the blocks.

6,547/15. HATCHES FOR SHIPS AND LIKE VESSELS. W. O. JONES, OF 5, SHEFFIELD PLACE, MUMBLES, GLAMORGANSHIRE.

This is a modification of the self-opening hatch patented under No. 25,121 and dated November 4, 1913. Whereas that patent related to a pivoted hatch, which, on being closed, tensioned a spiral spring contained within a housing on the hatch, the hatch thus being automatically opened



when released, the present modification relates to a sliding hatch of the type which, on being closed, tensions a spiral spring as before, the motion of the hatch tensioning the spring through the medium of a rack and pinion, a cog-wheel and chain, or the like. According to the invention, means such as a bevel gearing wheel in engagement with a similar wheel on a shaft are provided for closing the hatch against the strength of the spring, which constantly tends to open it. The strength of the latter is also capable of regulating by means of the bevel gearing, the pinion or cog-wheel on the spring returned shaft being detachably secured for this purpose. Pawl and ratchet means are also provided for normally preventing the return of the hatch cover under the action of the spring.

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Fix the Responsibility

BEFORE the Legislature of the State of New York adjourns its present session drastic action should be taken to fix the responsibility for a condition which has become apparent in the building of the New York State Barge Canal. Although the canal and its locks are intended to accommodate barges capable of carrying 3,000 tons of cargo, yet at various points sharp bends in the canal will prevent the navigation of barges carrying more than 2,000 tons. In other words, the capacity of barges destined for use on the State Barge Canal must be one-third less than the locks of the canal are capable of accommodating.

The tendency in shipbuilding of late has been towards a steadily increasing size of cargo vessels. In fact, it is safe to say that the average cargo vessels of to-day have double the cargo capacity of similar vessels built a few years ago. As it is estimated that when the barge canal is completed the time of passage from Lake Erie to the Hudson River will be reduced from ten to four days, it surely is imperative from an economical standpoint that the largest possible vessels can be used in this service.

Would it not be well for the Legislature to have these sharp curves straightened out now while it is comparatively easy to do so, rather than to wait until the canal is in commission, and then have to do the work later at much greater expense?

Meantime, the authorities should find out who is responsible for these restrictions.

Classification and Filing of Engineering Data

TO obtain the greatest possible benefit from the mass of technical information and data published in the engineering press and in the proceedings of technical societies, the drafting departments of well-organized shipbuilding establishments usually adopt some system of classifying and filing such data so that it may be immediately available for reference. Considering the wide variety of sources from which such data are obtained, and the diversified forms in which it is presented, it is hardly likely that there is much uniformity in the reference files of different shipyards. The basis of the system in probably every case is, or should be, a card index arranged so that any portion of an article or paper can be instantly found, but the details may vary widely. As this subject is well worth a thorough discussion, we would suggest that our readers send to this office a brief statement explaining the methods which they are using for filing and classifying such engineering data. It will then be possible to present in a future issue a symposium in which methods can be compared and perhaps the best and most useful system established as a standard.

Status of the Submarine

IN the series of articles on submarines by Mr. Simon Lake, which is concluded in this issue, attention has been directed to the improvements which must be made in future submarines to make them effective weapons for offensive warfare. The status of the submarine as it exists to-day is such that it may very properly be called a perfected craft as far as its construction and methods of operation are concerned. No further improvements are essential or necessary in the principles of operation. Types of submarines are in existence whose capabilities are such that when proper attention has been given to stream lines, stability and pressure-resisting qualities, they may be designed for any desired service, so far as the boat itself is concerned. But the weakness of the vessel lies in its propulsive machinery, for both surface and submerged operation.

As far as prime movers for submarines are concerned, steam machinery has generally been found unsuited for the work, the principal objections to its use being the difficulty in instantly housing the comparatively large smokestack when submerging, the valuable space occupied, the unavoidable storage of heat in a confined space, and the impossibility of immediately getting underway at full power on coming to the surface after a long submergence. The gasoline (petrol) engine has been discarded because of the numerous explosions resulting from the accumulation of dangerous gases within the hull. The Diesel engine, while generally accepted at the present time as the motive power for submarines, has by no means proved entirely satisfactory. Although this type of engine has given excellent service in surface vessels, where the weight and space occupied are not important features, nevertheless, when it comes to an installation in a submarine, the size and weight of the engine are strictly limited, while at the same time a wide range of speeds is demanded. Reversibility is also a desirable feature, but it has been obtained in the Diesel engine only at the expense of much additional complication. For submerged work, the storage battery is excessively heavy for the energy which it stores. It is also bulky, so that only sufficient energy can be carried to propel a modern submarine while submerged at about 11 knots for one hour, at about 8 knots for three hours, or at about 5 knots for twenty hours.

While Mr. Lake emphasizes the necessity for immediate improvement in the propelling machinery of submarines if the vessel is to be successful for offensive warfare, he points out that the improvements are by no means so important if the submarine is to be restricted to defensive warfare only. For purely defensive purposes, the present types of submarines, notwithstanding their defects, have conclusively proved in the present war their capability of maintaining their lines of defense,

while in addition some of them have found time to do effective offensive work. As a strictly defensive weapon, Mr. Lake has laid special stress on the type of craft which he has termed the "amphibious submarine"—that is, a small vessel of about 200 tons displacement which can be hauled out of the water on special trucks and transported at high rates of speed over the railways on land to points of attack. Such vessels, Mr. Lake estimates, could probably be built for about $300,000 (£61,500) each, capable of making a speed of 10 knots on the surface and about 8 knots submerged. In the United States such small boats can be transported from New York to San Francisco in three days, from New York to Boston in five hours, or from New York to New Orleans in thirty-six hours in perfect safety.

Such a system of coast protection, enabling the quick mobilization of a large number of submarines at any threatened locality, while a distinct novelty, has much to recommend it from the standpoint of economy, utility and expediency.

Submergence Test of a Submarine

One of the interesting performances required of a submarine during its acceptance trials is that known officially as the deep submergence test. In most cases in the United States Navy the requirement for coast submarines is a submergence to a depth of 200 feet for a period of not less than ten minutes, the hull not to suffer any serious deflections nor develop any serious leaks during this time. The pressure at this depth in sea water is 88 pounds per square inch.

A test of this nature was recently successfully performed on the Lake type submarine *G*-3, recently completed at the New York Navy Yard. The test was carried out under the supervision of a naval constructor by a wrecking and salvage company, especially skilled in this kind of work.

A few days before the test was to be made a spot in Long Island Sound, at which there is approximately 200 feet depth of water, was located and buoyed. The vessel at the navy yard was overhauled, valves tested, depth gages calibrated, air flasks and batteries charged, salvage hoisting straps fitted around the hull, and all the various arrangements necessary to ensure a successful test were completed. As it was desired to complete the test in as short a time as possible, the vessel was put in condition, practically ready for her submergence, at the yard and then towed by a seagoing wrecking tug to the scene of the test. In addition to the tug, the contractor furnished a salvage vessel, which was equipped with air compressors and diving gear.

A preliminary submergence was made in about 60 feet of water to familiarize the men who conducted the test with their duties, and, in order to see that every detail was in perfect order. There are two practicable methods for submerging vessels on this kind of test—one is to lower the vessel with no crew on board. Slings are placed about the vessel and fastened to a ship's crane; a small amount of negative buoyancy is then taken and the ship sealed from the outside and lowered. This method has the disadvantage that no inspection can be made until the vessel comes to the surface, and that there is no guide, except the strain on the cable, as to whether the vessel is taking in water. The other method is to haul the vessel down on its own anchor cable with positive buoyancy. In this method a skeleton crew is aboard and complete control of the vessel is maintained. The vessel may be stopped at any depth and inspection made for leaks, deflections of hull taken, etc. In case of emergency the vessel can be brought to the surface immediately by blowing the ballast tanks with compressed air.

This latter method was employed for the *G*-3, a crew of four men with two observers going down with the vessel. The ship's anchor was lowered to the bottom and all hatches closed and secured. Then water ballast was taken on until the vessel had less buoyancy than the weight of the anchor. The ballast was so distributed as to give the vessel three to four degrees trim by the stern. Then, when the strain was put on the anchor cable the vessel settled to an even keel, thus avoiding any planing effect during descent.

Deflection battens were rigged at certain frames for measuring elongation and compression of the hull—observations were taken at depths of 50, 100, 150 and 200 feet. These data are not available for publication, but it may be stated that the vessel was found to be tight and the hull deflections not excessive.

Communication was maintained with the surface by the telephone, which is carried in a marker buoy as a part of the vessel's equipment. High-pressure air hose was attached to a valve in the ship's side, and the upper end fastened to the small boat which carried the telephone. In case of necessity, the air hose would have been connected to the salvage vessel's compressed-air line, and the *G*-3, thus filled with high-pressure air, which would have excluded any water and brought the vessel to the surface.

The vessel actually remained at the maximum depth about 14 minutes. On coming to the surface, the ballast tank valves were secured, the anchor hauled up and the vessel towed back to the navy yard—the total time of the test consuming less than 24 hours.

Form Coefficients of Vessels

BY ARTHUR R. LIDDELL

The various coefficients of form of a ship are usually treated as arbitrary factors, to be varied according to the taste of the designer. In reality they are much less arbitrary than they seem, and the designer's taste in the choice of them varies between not very wide limits. It is true that the block coefficients of cargo steamers may range somewhat from .6 to .85, but the lower limit is met with only in very small and the higher one only in very large vessels.

If we consider the prismatic coefficient, *i. e.*, that resulting from the division of the displacement by the product of midship area multiplied by length, as the deciding one for comparative fineness of ends of vessels of given dimensions, we find that a degree of fineness of .65 in a 100-foot ship will correspond with one of about ½ (1 + .65) = .825 in a 400-foot ship and with one of about 1/3 (2 + .65) = .883 in a 900-foot ship; that is to say, with similar fineness of ends the 100-foot ship has no parallel middle body, the 400-foot one has a parallel middle body extending over half her length, and the 900-foot one has a parallel middle body extending over two-thirds of her length. The reason of this is that the proportions borne by the length to the breadth, to the draft, and to the square root of the midship area, respectively, increase with the size of vessels. Midship area in fact increases very much as length, or we may put it that $\sqrt{\text{midship area}}$ increases as $\sqrt{\text{length}}$ instead of directly as the length, as might at first sight be supposed. If we take designer's taste to vary by about 2 percent in the 900-foot ship, we may get .9 for her prismatic coefficient instead of .883, and the corresponding prismatic coefficient for the 100-foot ship becomes .7 instead of .65, giving a difference of about 8 percent. Let us take

TABLE OF COEFFICIENTS OF FINENESS A (FOR CARGO VESSELS)

Length in Feet.	Breadth in Feet.	Ballast Draft in Feet.	$\sqrt{\text{Length}}$ in Feet.	Prismatic Coefficient Φ	Block Coefficient δ	Loadline Coefficient α	Midship Section Coefficient β
100	22.3	11.2	10	.6 — .7	.51—.62	.71—.79	.84 —.89
225	33.4	16.8	15	.73— .8	.655—.75	.815—.865	.90 —.93
400	44.6	22.4	20	.80—.85	.75 —.81	.87 —.90	.93 —.95
625	55.7	28.0	25	.84—.88	.80 —.835	.895—.915	.95 —.955
(900)	(66.9)	(33.6)	30	.87—.90	.825—.865	.91 —.93	.955—.965
				Ratios in $\alpha^{1.5}$	which above coefficients vary: α^2	$\Phi^{\frac{2}{3}}$	$\sqrt{\alpha}$

TABLE OF COEFFICIENTS OF FINENESS B (FOR CARGO-PASSENGER VESSELS)

Length in Feet.	Breadth in Aeet.	Ballast Draft in Feet.	$\sqrt{\text{Length}}$ in Feet.	Prismatic Coefficient Φ	Block Coefficient δ	Loadline Coefficient α	Midship Section Coefficient β
100	20	10	10	.....	.....	.....	.....
225	30	15	15	.43 —.50	.33 —.40	.57—.63	.76—.80
400	40	20	20	.575—.625	.48— .535	.69—.73	.83—.86
625	50	25	25	.66 —.70	.58— .63	.76—.79	.87—.89
(900)	60	30	30	.72 —.75	.645—.69	.80—.83	.90—.91
				Ratios in $\alpha^{1.5}$	which above coefficients vary α^2	$\Phi^{\frac{2}{3}}$	$\sqrt{\alpha}$

$$\frac{\text{length}}{\text{breadth} \times \text{draft}} = \frac{1}{2.5}$$ as a standard for a cargo-passenger ship,

and

$$\frac{\text{length}}{\text{breadth} \times \text{draft}} = \frac{1}{2}$$ as a standard for a cargo ship,

and consider the corresponding tables *A* and *B*. These embody an attempt to reduce to order the variation which the element of size imposes on the coefficients of vessels. In these, it will be observed, the prismatic coefficient is made to vary with $\alpha^{1.5}$, the block coefficient with α^2, and the midship section coefficient with $\sqrt{\alpha}$, α being the coefficient of the load waterline. The coefficients given will be found to agree fairly well with general practice. Should the midship section coefficient chosen for a design be greater or less than that given in the table, the block coefficient in the same line may be increased or diminished to the same degree. The prismatic coefficient, *i. e.*, the degree of fineness of the ends of the vessel, then remains as before. It may be observed that the coefficient of the deckline will generally be about equal to the square root of the prismatic coefficient.

When a vesseel is lengthened, a parallel middle body having a block coefficient equal to the coefficient of the immersed midship section is inserted. The new block coefficient then becomes

$$= \frac{\text{old length} \times \delta + \text{additional length} \times \beta}{\text{new length}},$$

where δ is the old block coefficient and β the midship section coefficient. As regards speed, the lengthening of a vessel may be advantageous in case she has hitherto been too short for her area of midship section and for her speed. If her length hitherto, say for passenger work, has been = ½ (breadth × ballast draft), and the proportion borne by her length in feet to the product of $(\text{knots})^2 \times .563$ has been equal to 2¼, it is probable that any considerable increase of length will result in diminution of propulsive efficiency, in wetness, and in bad steering, while the carrying capacity will be less than if the midship section coefficient could have been suitably increased, as it would have been in a new design embodying the extra length.

The inner reason why, with given fineness of ends, the midship section of a small vessel is made finer than that of a larger one is that the critical wave, *i. e.*,, the wave having the same length as the vessel, becomes hollower with decrease of dimensions. To obtain good sea qualities, the rise of floor of a small vessel is, in ordinary practice, increased perhaps so far that an OG-bottom results, the base line being thereby artificially brought down farther below the main body. Were it not undesirable in view of docking and on other such grounds, the keel of a small steamer might be arched from sternpost to forefoot, and her floor amidships be designed with a very small rise, while the area of the midship section would be the same as that usually given.

The dimensions given in the tables are length, breadth and ballast draft, the later being made to vary with $\sqrt{\text{length}}$, and being regarded as the shallowest admissible for sea work.

The values given are not necessarily the best for the respective ranges of dimensions, but they agree fairly well with current practice. For drawing-office use they may be varied to suit the practice of the designer who may apply them, and any desired number of additional grades may be interpolated. The use of such tables will save a great deal of trial and error work. Assume, for instance, that a designer has particulars of a successful cargo vessel and wishes to obtain correspondingly good results in a larger one. A reference to Table A will show the necessary alteration in the proportions of length to area of midship section, etc., and the degree in which the coefficients of the smaller vessel must be varied to adapt them to the larger one.

Marked Increase in Japanese Shipping to the United States.—According to statistics published by the Department of Commerce at Washington for January, there were marked increases in the value of merchandise imported to the United States in American, British and Japanese ships. In January, 1916, as compared with January, 1915, American shipping increased about 60 percent, British shipping about 80 percent and Japanese shipping about 250 percent. For the seven months' period ending in January, 1916, as compared with the similar period ending in January, 1915, there was a gain of 55 percent for imports under the American flag, 10 percent under the British flag and about 125 percent under the Japanese flag. These figures show that while the war has stimulated trade under the American flag, the greatest benefits have been derived by British and Japanese shipping.

A Criterion of Propeller Surface

BY PETER DOIG

In solving the problem of best dimensions for a screw propeller to meet certain conditions, the three chief characteristics to be determined are diameter, pitch and surface; the thickness of blades, their number and outline and sectional shape being usually of secondary importance. When the power, speed and revolutions are of moderate amount, the order in which they may be placed is, first, diameter; second, pitch; and third, area of blades.

But when high power, speed and revolutions are under consideration the relative order then frequently becomes, first, area of blades; second, diameter; and third, pitch.

Assigning suitable diameters and pitches, though never an easy matter, is much assisted by deduction from experiment on model screws; but here little or no help is got for the computation of the area of blades which shall be sufficient and no more than sufficient; since it is well established by model and full-size experiments that efficiency is lessened, through frictional losses, by increase in area after a certain amount has been provided.

In the best modern practice the minimum ratios of developed surface to area of the disk enveloping the blade tips lie usually between about .28 and .34. Anything smaller, though indicating high efficiency in model experiments with very thin blades, involves in full-size abnormal root thickness to meet requirements of strength, and then returns relatively poor efficiency.

Large increase over these values is usually due to the desirability of providing sufficient breadth of blade to ensure effective contact with the water, or to diminish the intensity of thrust pressures; failure to guard against the alternatives being regarded as responsible for the phenomenon of "cavitation." By some investigators high blade velocities are thought to produce a certain "cascading" of the water round the blade resulting in parts of the surface giving no useful thrust, which defect has to be met by widening the blade; while by others the high thrust pressures per unit surface in screws of insufficient area are regarded as causing the pressure head, due to superincumbent water and atmosphere, to fail in supplying the screw with a "solid" medium.

High blade velocities are, *cæteris paribus,* proportional to revolutions, and similarly to diameter; and thrusts per unit surface increase with the value

$$\left(\frac{H E}{S D^2}\right)$$

where H is horsepower of engines per screw, E efficiency of screw, S speed in knots (HE/S being thus a measure of total thrust) and D diameter. Since these are the main factors taken into consideration by designers, there would seem a possibility of constructing some eclectic semi-empirical formula such as

$$\text{Disk area ratio of practice} = C + K R^m D^n \left(\frac{H E}{S D^2}\right)^p \ldots (1)$$

where C is the minimum disk area ratios of practice having the values previously mentioned (.28 to .34), and m, n and p are indices, giving approximation to the relative "weights" of R, D, and

$$\left(\frac{H E}{S D^2}\right)$$

in the expression.

On trial of various combinations of values being made with an extensive set of modern data, close accordance with practice was obtained with

$$K = \frac{1}{10{,}000}; \; m = 1; \; n = 3/4; \; p = 1/4.$$

Substituting in (1) this becomes

$$D.\ A.\ R.\ \text{of practice} = C + \frac{R D^{3/4} H^{1/4} E^{1/4}}{10{,}000\, S^{1/4} D^{1/2}} = C + \frac{R}{10{,}000} \sqrt[4]{\frac{D H E}{S}}$$

Since E varies between, say, .60 and .70, $\sqrt[4]{E}$ varies only between .88 and .91, and this term having but a small effect on the values of the formula may be neglected. We thus get:

$$D.\ A.\ R.\ \text{of practice} = C + \frac{R}{10{,}000} \sqrt[4]{\frac{D H}{S}}$$

It will be noted that mechanical efficiency of engine and variation of "wake" are not considered in the formula. But as they also enter as their fourth roots they are, like E, of minor effect.

The values of this expression, using .30 for C throughout, have been calculated for the results of over forty vessels, most of which will be found in the technical press*, and tabulated side by side with the actual area ratios. None of the fast vessels in this list has been a failure through cavitation; good performances as far as propulsion is concerned having been obtained in all cases at the *designed* speed.

On comparing the two columns of disk area ratios, it will be observed that higher values than the actual are generally given by the formula in the case of destroyers. This accords with the practice of other navies than the United States (to which the examples given belong); and, further, allows for the extent of "pressing" above designed speeds, to which they have been subjected. For example, No. 18, the *Monaghan,* at the designed speed of 29.5 knots, would take about 11,200 brake horsepower at 770 revolutions. This gives

$$D.\ A.\ R. = .30 + \frac{770}{10{,}000} \sqrt[4]{\frac{5.25 \times 3730}{29.5}} = .69$$

This is very close to the actual value, which was .68. Then again, in No. 15, the *Drayton,* an explanation of the large value obtained by the formula will be found in the low propulsive efficiency, .43, which immediately suggests cavitation and insufficient area for the "pressed" speed.

In the case of reciprocating-engined vessels the differences are of no great moment, as equally good performances can be got with some variation of area, provided the power, speed and revolutions are not high. This is because larger areas have thinner blades, the extra frictional losses being balanced by the higher efficiencies attributable to thin blades. In this connection it may be noted that the *Drake,* a highly successful vessel, with .37 D. A. R., was followed by a class of cruisers (the "county" ships) with larger values of area ratio, and equally good results.

Another point, to which attention should be drawn, is that in all cases in the table there is no restriction on diameter through limited draft or clearances. When such exists the proper area for use with the small diameter can be found from the formula in the manner illustrated by the folowing example, an actual case of a single-screw channel steamer in which the draft limited size of screw to a great extent. The vessel was of block coefficient about

* A large number in the *Journal of the American Society of Naval Engineers,* 1907 to date.

FORMULA: DISK AREA RATIO $= C + \frac{R}{10{,}000}\sqrt[4]{\frac{D\,H}{S}}$ { R=REVS. PER MIN. D=DIAMETER. H=HORSEPOWER (PER SCREW). S=SPEED; C=.30.

No.	Name.	Total I. H. P. or B. H. P.	Speed Knots.	Average Revs. Per Min.	Propeller. No. of Blades.	Propeller. Diam.	Propeller. Pitch.	Actual Disk Area Ratio.	Calculated D. A. R. by Formula.	Remarks.
1	U. S. B. S. North Dakota	31300	21.66	280	3	13.0	10.3	.54	.57	Twin screw, turbine.
2	U. S. B. S. Arkansas	28530	21.05	324	3	10.0	8.2	.58	.55	Quad screw, turbine.
3	U. S. B. S. Wyoming	31440	21.22	319	3	10.0	8.2	.58	.55	Quad. screw ,turbine.
4	U. S. B. S. Florida	40500	22.08	364	3	9.17	8.5	.62	.59	Quad. screw, turbine.
5	H. M. Battleship	about32000	21.50	310	3	9.6	8.5	.51	.54	Quad. screw, turbine (approx. figures).
6	U. S. Scout Chester	23960	25.90	603	3	6.0	6.0	.67	.67	Quad. screw, turbine.
7	Chinese Cruiser Fei-Hung	7490	20.30	535	3	5.35	5.17	.61	.57	Triple screw, turbine.
8	U. S. T. B. D. Warrington	12846	30.12	641	3	6.67	6.17	.66	.69	Twin screw, turbine.
9	U. S. T. B. D. Flusser	11270	30.41	798	3	5.25	4.83	.69	.70	Triple screw, turbine.
10	U. S. T. B. D. Cassin	15310	30.14	602	3	7.33	6.67	.68	.66	Twin screw, turbine.
11	U. S. Scout Salem	19200	25.95	378	3	9.50	8.7	.62	.59	Twin screw, turbine.
12	U. S. T. B. D. Beale	11800	29.65	783	3	5.25	4.83	.67	.70	Triple screw, turbine.
13	U. S. T. B. D. Preston	10920	29.18	779	3	5.00	4.75	.68	.69	Triple screw, turbine.
14	U. S. T. B. D. Lamson	10600	28.60	745	3	4.83	5.00	.69	.67	Triple screw, turbine.
15	U. S. T. B. D. Drayton	15520	30.80	844	3	5.25	4.83	.69	.76	Triple screw, turbine, (propulsive effic. low).
16	U. S. T. B. D. Benham	16850	29.59	585	3	7.70	6.67	.68	.70	Twin screw, turbine.
17	U. S. T. B. D. Perkins	11670	29.76	593	3	6.58	6.35	.65	.65	Twin screw, turbine.
18	U. S. T. B. D. Monaghan	12410	30.45	817	3	5.25	4.83	.68	.72	Triple screw, turbine.
19	U. S. T. B. D. McCall & Burrows	13163	30.66	816	3	5.27	4.83	.71	.73	Triple screw, turbine.
20	U. S. T. B. D. Patterson	12622	29.69	782	3	5.25	4.83	.67	.71	Triple screw ,turbine.
21	Channel Steamer	11000	22.5	460	3	6.7	5.09	.57	.57	Triple screw, turbine.
22	Passenger Str. Camden	4530	19.	552	3	5.	4.5	.51	.54	Triple screw, turbine.
23	Creole	7180	16.71	243	3	10.4	8.2	.43	.47	Twin screw, turbine.
24	Center screw of Olympic	16000	22.0	165	4	16.5	....	.57	.57 (C=.4)	Triple screw, combination (approx. figures).
25	Center screw of Liner	6700	17.6	250	3	10.0	9.5	.59	.60 (C=.4)	Triple screw , combination.
26	H. M. S. Drake	31400	24.1	123	3	19.0	23.0	.37	.43	Twin screw, reciprocating.
27	H. M. S. "County" Class	21500	23.2	141	3	15.8	19.5	.41	.43	Twin screw, reciprocating.
28	U. S. B. S. Texas	28373	21.05	124.6	3	18.65	20.0	.37	.43	Twin screw, reciprocating.
29	U. B. S. Delaware	26500	21.42	126.8	3	18.25	19.75	.40	.43	Twin screw, reciprocating.
30	U. S. Scout Birmingham	14700	24.00	191	3	12.5	15.3	.41	.45	Twin screw, reciprocating.
31	Liner	20000	21.7	90	3	19.5	28.0	.40	.39	Twin screw, reciprocating.
32	Liner	22000	19.5	90	4	21.0	24.0	.39	.39	Twin screw, reciprocating.
33	U. S. Collier Proteus	7200	14.7	102	3	16.5	16.4	.42	.38	Twin screw, reciprocating.
34	U. S. Collier Nereus	6900	14.6	99	3	16.5	16.4	.42	.38	Twin screw, reciprocating.
35	U. S. Collier Orion	6940	14.5	95	3	16.5	18.0	.38	.38	Twin screw, reciprocating.
36	U. S. Collier Mars	4150	13.2	99	4	14.75	14.25	.40	.37	Twin screw, reciprocating.
37	Motor Boat Dixie II	170	26.0	1120	3	1.95	2.67	.54	.51	Single screw, gasoline (petrol) racer.
38	U. S. Oil Barge (Gov't Ship)	178	6.23	206	3	6.75	3.5	.39	.38	Single screw.
39	Yacht	330	11.2	146	4	7.0	10.0	.35	.36	Single screw, reciprocating.
40	Yacht	101	9.1	184	4	4.63	6.25	.39	.35	Single screw, reciprocating.
41	Yacht	237	10.2	124	4	7.75	10.0	.31	.34	Single screw, reciprocating.
42	Yacht	2600	15.0	164	4	9.3	10.4	.42	.39	Twin screw, reciprocating.

.60, horsepower 3,200, revolutions 90, and desired speed 15 knots. On solving for the approximate best dimensions by the methods of the writer's paper on "Propeller Design" (International Marine Engineering, June and July, 1913), the diameter (unrestricted) comes out at 17.5 feet. By the formula the disk area ratio results—

$$D.\,A.\,R. = .30 + \frac{90}{10{,}000}\sqrt[4]{\frac{3200 \times 17.5}{15.0}} = .37$$

With 13 feet diameter (the maximum allowable) this corresponds to an area of only about 49 square feet; but on 17.5 feet 90 square feet is given by .37. This area (90 square feet) was found to be the best after several trials, on 13 feet diamter. For really good propulsive results the solution here was, of course, the substitution of twin for single-screw machinery.

The center screws on the type of ships with combined reciprocating and turbine engines have relatively great power put through them. Here the value of the constant *C*, instead of about .28 to .34, should be increased to .35 or .40 to allow sufficient area. This is because the thickness for strength requirements is then considerable, and hence breadth of blade has to be large to give a transverse sectional shape of fair efficiency.

The case of towboat propellers is obviously a special one; much larger area being needed for the requirements of maneuvering and steady gripping power with heavy loads in foul weather than would be needed for a similar vessel running "free." Excessively large areas have often been entailed by the use of cast iron wheels with necessarily very thick blades.

It may be pointed out that considerable latitude seems to exist in the possible thrusts per square inch of surface; and that by this method or by allowing for tip velocities no consistent rules of anything like equal accuracy to the above formula have been deduced.

In conclusion, the writer would draw attention to the great variety of ships dealt with in the above table. The range covers from .3 to .7 disk area ratio, and includes a barge, racing motorboat, destroyers, liners, battleships, etc.

Recent Launchings

The twin-screw lighthouse tender *Rose,* under construction for the Lighthouse Service on the coasts of Washington and Oregon by the Anderson Steamboat Company, Seattle, Wash., was launched on February 19. The hull is of steel, 127 feet 6 inches long overall, 24 feet 6 inches molded beam, 11 feet depth of hold, and at a draft of 7 feet displaces 390 tons. Propulsion will be by two sets of triple expansion reciprocating engines supplied with steam by two oil-fired watertube boilers.

The American-Hawaiian steamship *Arborean,* 404 feet long, designed for the lumber trade, was launched on February 29 at Sparrows Point, Md., by the Maryland Steel Company.

The steel hull for the derrick *Evelyn,* building for the Newton Supply Company by the Clinton Shipbuilding Company, Philadelphia, Pa., was launched on March 2.

The Wilmington Steamboat Company's new steamer, *City of Camden,* 110 feet long and of 750 gross tons and 15 knots speed, was launched by the Harlan & Hollingsworth Corporation at Wilmington, Del., on March 4.

The United States torpedo boat destroyer *Sampson* was launched at the yards of the Fore River Shipbuilding Corporation, Quincy, Mass., on March 4. The vessel was christened by Miss Marjorie Sampson Smith, daughter of Captain Roy C. Smith, U. S. N., and the eldest granddaughter of Admiral Sampson.

TWIN-SCREW PASSENGER AND MAIL STEAMSHIP OF 15,600 TONS DISPLACEMENT, BUILT AT AMSTERDAM, HOLLAND



Fig. 1.—S. S. *Jan Pieterszoon Coen*



New Dutch Passenger and Mail Steamship

Twin-Screw Vessel Built by the Nederlandsche Scheepsbouw Maatschaapij for the Netherland Steamship Company

BY FREDERICK C. COLEMAN

THE largest vessel built at any Dutch shipbuilding establishment is the twin screw passenger and mail steamer *Jan Pieterszoon Coen,* recently constructed by the Nederlandsche Scheepsbouw Maatschappij for the Netherland Steamship Company, and illustrated in the engravings on this and the following pages. This vessel is now in service between Amsterdam and the Dutch East Indies. Its dimensions are as follows:

Length, overall .....522 feet 6 inches
Length between perpendiculars.....503 feet 6 inches
Breadth, molded .....60 feet 4 inches
Depth, molded to shelter deck.....39 feet
Draft, loaded .....25 feet
Displacement .....15,600 tons
Deadweight capacity .....6,950 tons

There are seven decks, three being continuous over the whole length. Eight watertight bulkheads reach to the upper deck, with the exception of the collision bulkhead, which reaches to the shelter deck, and they divide the ship into nine watertight compartments. The ten watertight doors can be closed in case of emergency from the bridge by means of Stone-Lloyd's patent pneumatic hydraulic closing apparatus.

The propelling machinery consists of two triple expansion engines with cylinders 27, 44 and 75 inches in diameter, and 49¼ inches stroke, developing 6,000 indicated horsepower at 85 revolutions per minute. The speed is 15 knots at 25 feet draft. Steam is delivered at 210 pounds per square inch gage pressure by eight single-ended Scotch boilers having two furnaces each and a total grate surface of 520 square feet, and a heating surface of 21,000 square feet. The boilers have Howden's forced draft. The engines and boilers were manufactured by the Nederlandsche Fabrik van Werktuigen and Spoorweg-Materieel, of Amsterdam.

The steering mechanism consists of two engines, each of which may be used separately. One of the engines is a Hele-Shaw-Martineau patent electric hydraulic steering gear, and the other is a steam steering gear of Hastie's pattern. Both of these engines may be worked from the bridge by telemotor control.

The ship has two masts, the foremast carrying four

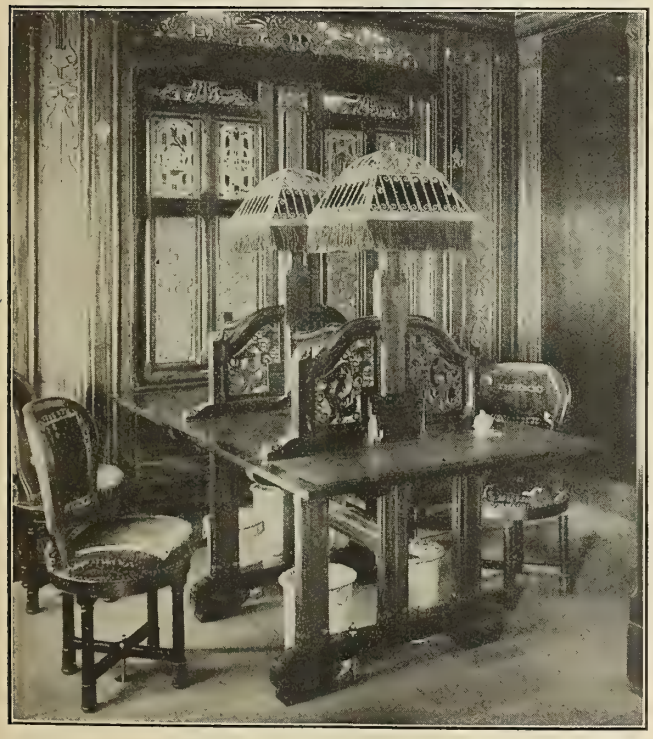


Fig. 2.—First-Class Writing Room



Fig. 3.—En Suite Staterooms

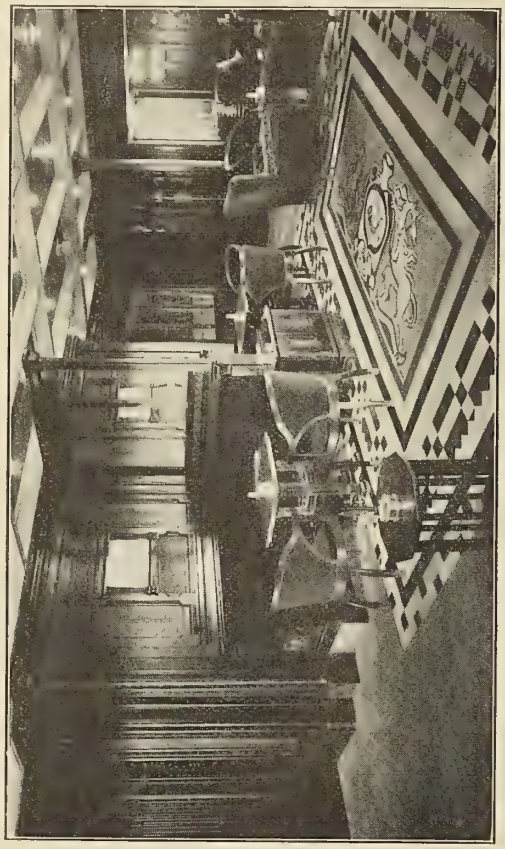


Fig. 5.—First-Class Smoking Room

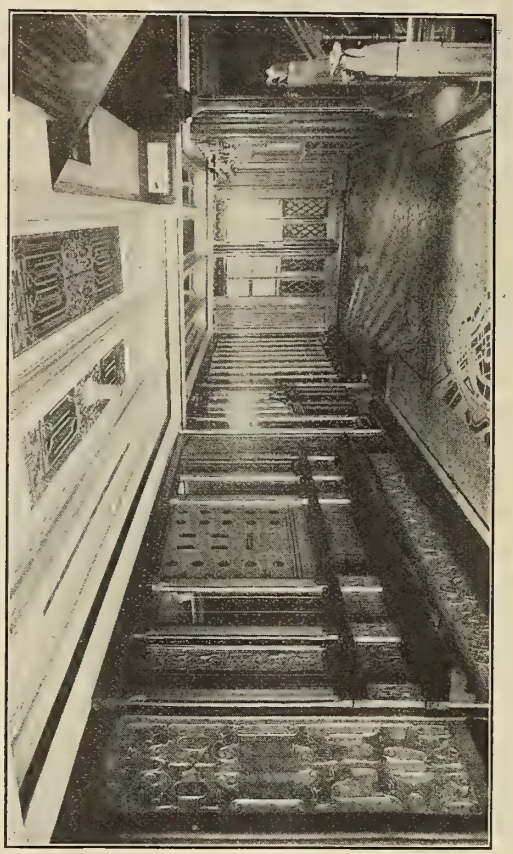


Fig. 7.—First-Class Lobby

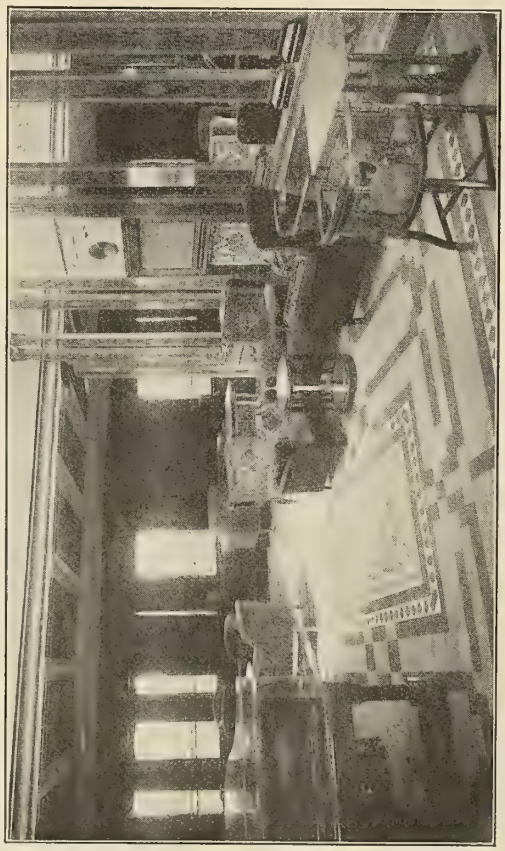


Fig. 4.—First-Class Saloon

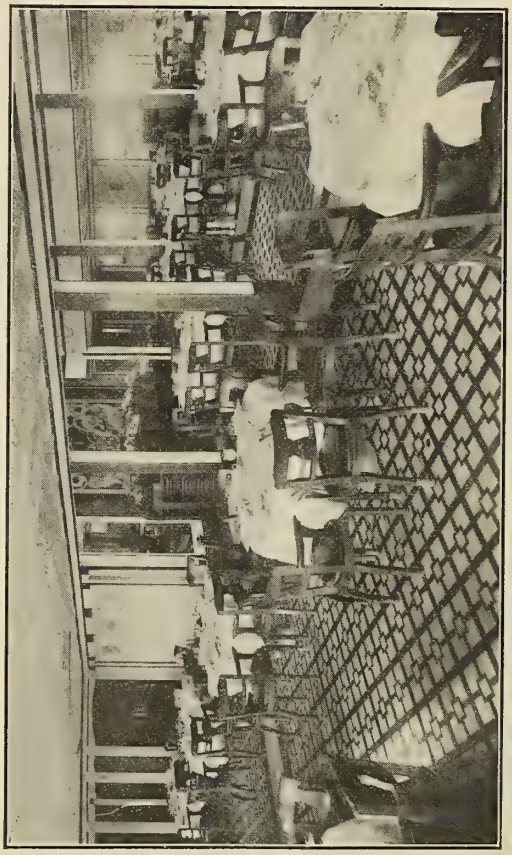


Fig. 6.—First-Class Dining Room

derricks of 6 tons lifting capacity each, and there is also a 25-ton derrick provided here to take specially heavy loads. The two derrick posts on the bridge deck have two 3-ton derricks. The derricks are worked by six steam winches, and in addition there are eight hydraulic cranes.

There is accommodation for 202 first class passengers in 107 cabins and four suite rooms, 129 second class passengers in 49 cabins, 46 third class passengers in 16 cabins and 42 fourth class passengers, and a crew of 261, making accommodation for a total number of persons on board of 680. As will be gathered by reference to the illustrations, the passenger apartments are most luxuriously equipped. In addition to the four suite cabins, each of which has a separate bath room, there are several saloons at the disposal of the first class passengers. These include a deck saloon 10 feet high, a smoking room 10 feet high, dining saloon with 138 seats, a verandah café, a nursery, gymnasium, and photographers' dark room.

The vessel is fitted with a Marconi wireless installation and submarine bells, and it is electrically lighted throughout. There are fourteen boats, inclusive of two motor boats, and all of these may be lowered by means of Welin quadrant davits. They provide sufficient room for all persons on board.

Merchant Shipbuilding in France

Since the outbreak of the European war the building of merchant vessels in the private shipyards of France has been greatly diminished, owing to the application of every available resource to military service. At the outset about 11 percent of the population of France was mobilized, leaving for commercial work only men either under eighteen or over fifty years of age and those incapacitated for military service. Furthermore, the invasion of northern France, which furnishes 80 percent of the nation's products from the mines and metal industries, has made the shipbuilders in France practically dependent upon England for shipbuilding materials.

In spite of these obstacles, however, the French shipbuilders are to be complimented upon the progress they have made, as shown by the following statement covering work finished or in hand since August 2, 1914:

At Dunkerque, the Ateliers & Chantiers de France has completed the passenger boat *Asie*.

At Havre, the Forges & Chantiers de la Mediterranée has completed the cargo boats *Conde* and *Belle Isle* and the passenger boat *Versailles*.

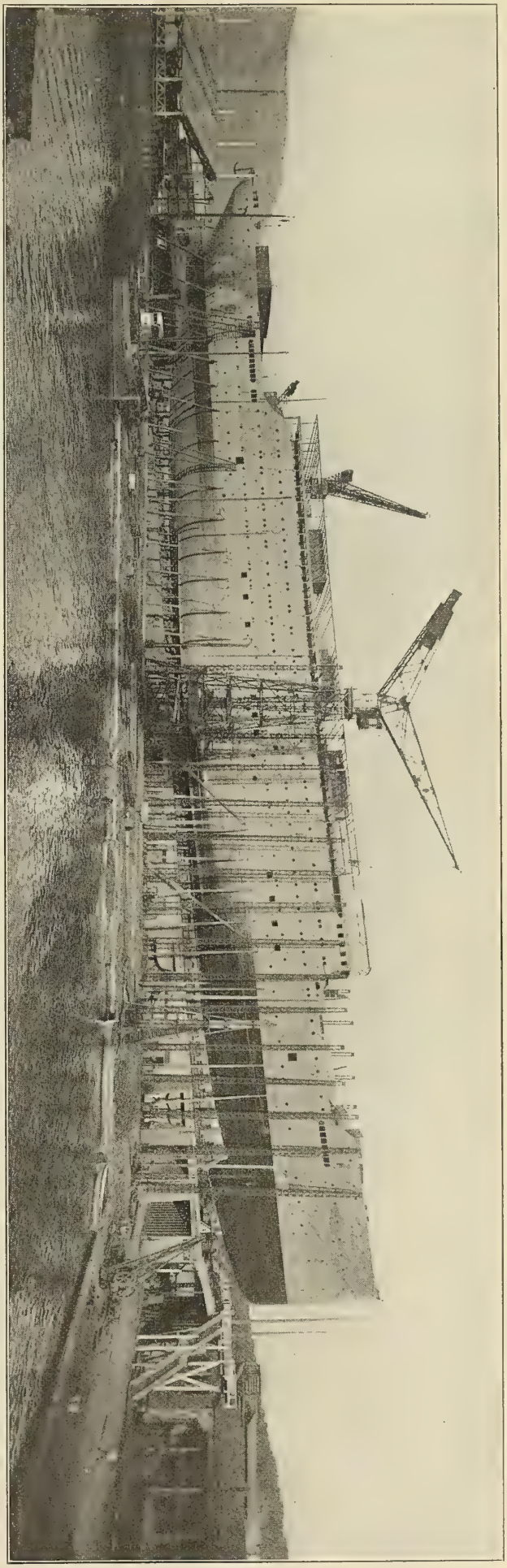
At Rouen, the Ste Ayme des Chantiers de St. Nazaire has completed the oil tanker *Meuse* of 7,400 tons deadweight and the cargo vessels *Ohio* and *Omnium* of 12,200 tons deadweight.

At St. Nazaire the above firm has under construction the passenger steamer *Paris,* of 36,650 tons, and the Chantiers de la Loire has built the passenger steamer *Sphinx*.

At Nantes, the Ateliers & Chantiers de la Loire has built the cargo boats *Chateau Lafitte, Saint Jean* and *Chateau Palmer,* and has in hand the *Chateau Latour* and another cargo boat of 4,000 tons.

At La Ciotat, the Chantiers & Ateliers de la Provence has completed the passenger steamer *Lafayette* and has under construction two passenger steamers of 780 tons and a cargo boat of 5,000 tons.

At La Seyne, the Forges & Chantiers de la Mediterranée has built the cargo boats *Gharb* and *Aurogny* and the passenger steamers *Providence* and *Massilia*.



S. S. *Providence* under Construction at the Yards of the Forges & Chantiers de la Mediterranée at La Seyne, France

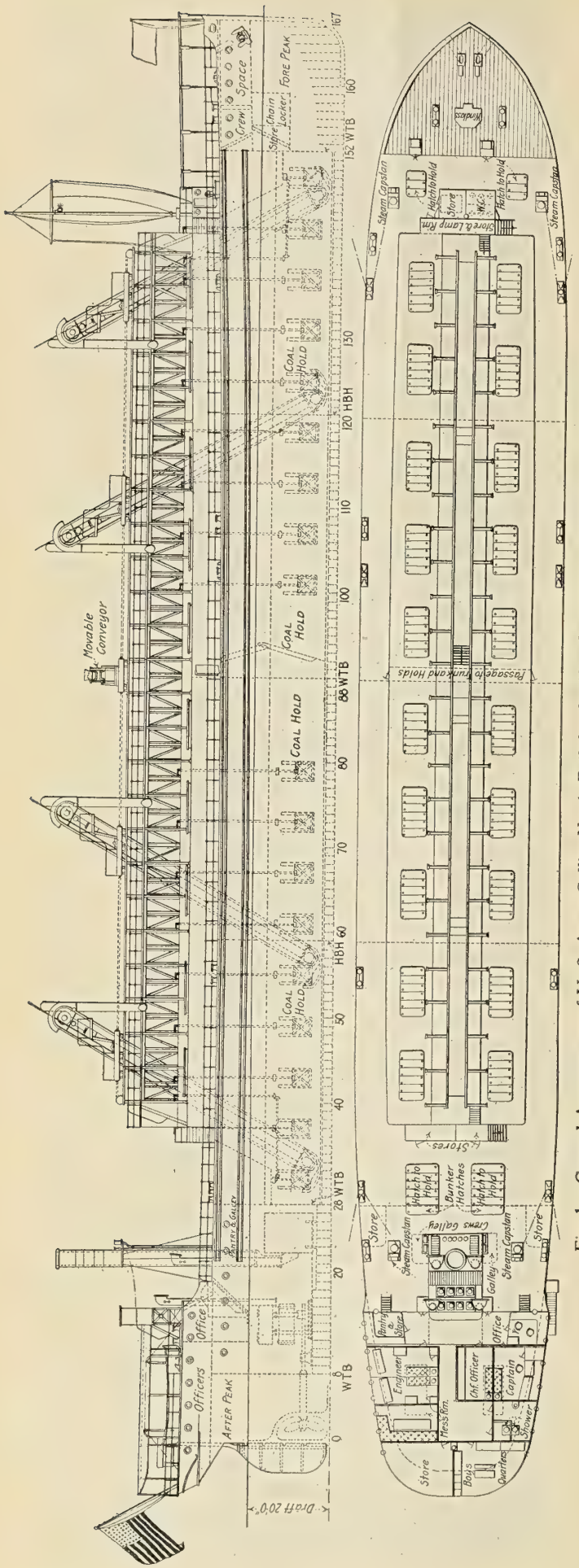


Fig. 1.—General Arrangement of U. S. Army *Collier No. 1*, Built by the Shanghai Dock & Engineering Company, Ltd.

United States Army Collier Built in China

Over a year ago there was completed at the yards of the Shanghai Dock & Engineering Company, Ltd., Shanghai, China, for the quartermaster's department of the United States army, Philippines division, Manila, P. I., a single screw steel collier of about 6,000 tons deadweight capacity on a draft of 20 feet. The vessel was built to meet the general requirements of a harbor coal hulk and was fitted with four coal bunkering elevators, coal shoots and weighing machines and one elevating coal conveyor capable of discharging at a height of 50 feet above the deep load waterline of the collier. The auxiliary propelling machinery was located aft, together with the pumps and turbine driven electric generating sets.

The principal dimensions of the vessel are as follows:

Length overall	362 feet
Length between perpendiculars	350 feet
Beam, molded	50 feet
Depth, molded	28 feet
Capacity of holds, including bunkers	6,000 tons

The hull has a straight stem and elliptical stern and

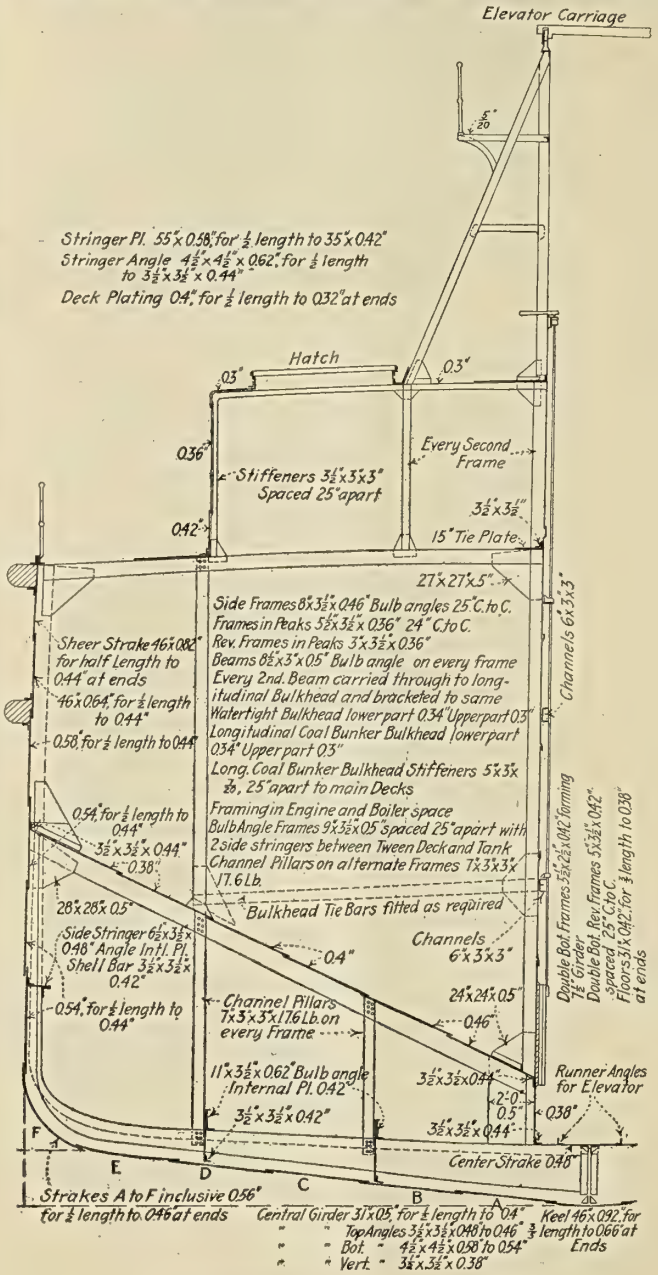


Fig 2.—Section in Way of Hold



Fig. 3.—Launch of U. S. Army *Collier No. 1* at Chinese Shipyard

there are four transverse watertight bulkheads, all extending to the main deck, as well as longitudinal coal division bulkheads for the elevator well and partial coal hold bulkheads as shown on the general arrangement plans and midship section. A double bottom extends from frame 28 to frame 152. The center girder is continuous 31 inches by .5 inch for one-half length amidships to 37 inches by .4 inch at the ends, with side well girders as shown on the plans. The flat keel is 46 inches wide by .92 inch thick for three-fifths of the vessel's length amidships tapered to .66 inch at the ends. There are two longitudinal girders on each side of the centerline formed of plate .42 inch thick with bulb angles 11 inches by 3½ inches by .62 inch on top of the floors.

The frames are 5½ inches by 3½ inches by .42 inch and the reverse frames 5 inches by 3½ inches by .42 inch, forming 7½-inch girders spaced 25 inches apart. The shell plating from the flat keel to the upper turn of the bilge is .56 inch thick for half the vessel's length amidships to .46 inch at the ends. From the upper turn of the bilge to the strake in way of the tank top at the side the plating is .54 inch thick amidships reduced to .44 inch at the ends. The sheerstrake is 46 inches by .82 inch for one-half length to .44 inch at the ends, while the strake below is .63 inch thick reduced to .44 inch at the ends.

The stem is an iron forging 10 inches by 2⅝ inches built according to Lloyd's rules. The stern post is 9 inches by 7 inches, reduced from the lower part of the rudder trunk to its head, where it is 7½ inches by 7 inches, secured to the transom floor plate by two vertical angles. The propeller post is 10 inches by 7 inches, bossed to take the propeller shaft. The rudder is of the single plate type with cast steel stock.

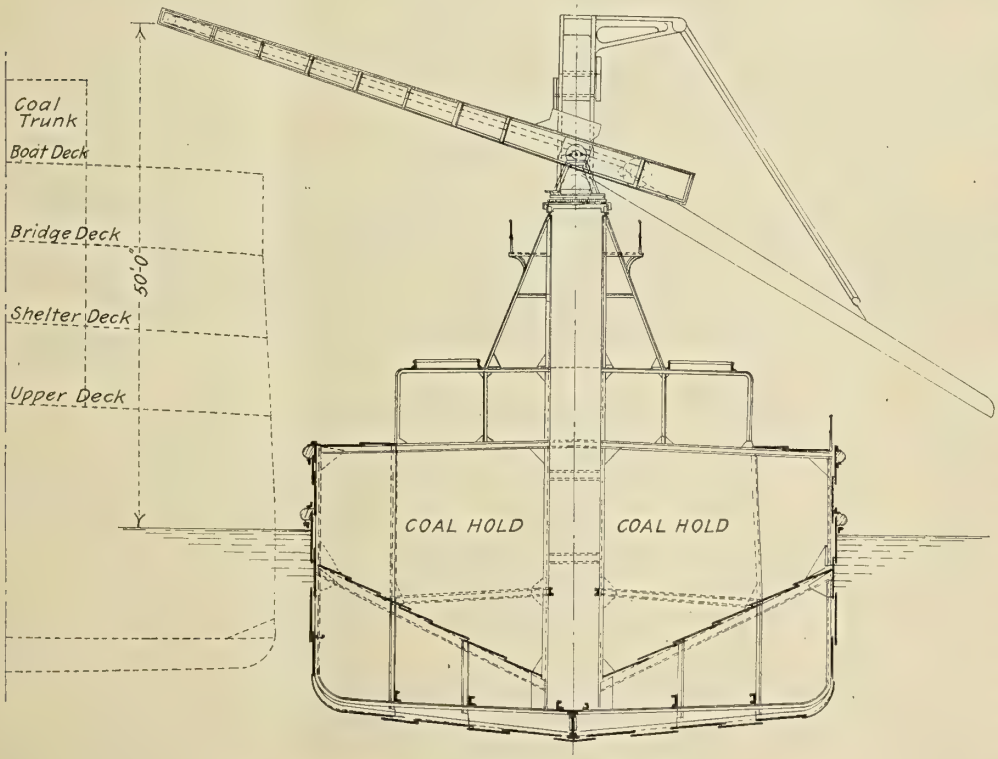


Fig. 4.—Midship Section, Showing Coaling Apparatus

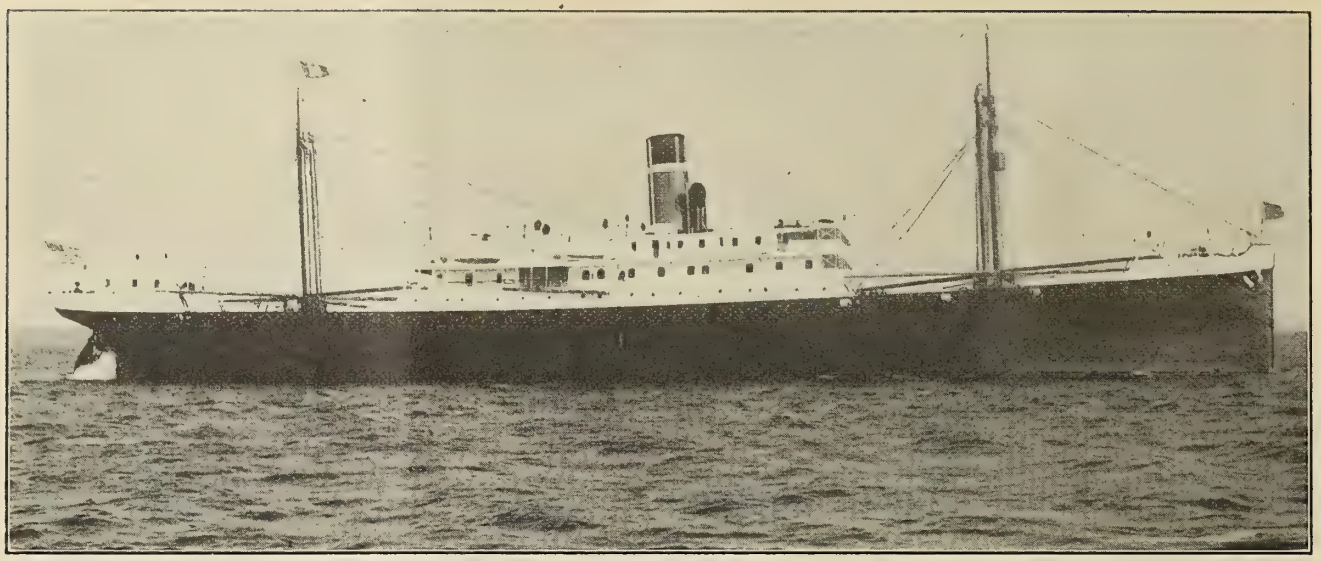


Fig. 1.—Munson Steamship *Munamar*, Built by the Maryland Steel Company, Sparrows Point, Md.

Designed for the passenger and cargo traffic between New York and the island of Cuba, the *Munamar* has been built with special regard to the comfort of passengers traveling in tropical climates, as well as for a rapid and economical cargo carrier. With a deadweight carrying capacity of 4,000 tons, she has averaged a speed of 14½ knots from dock to dock on the voyage between New York and Antilla, Cuba. During the trip from Nuevitas to New York, ending February 9, the vessel covered the distance of 1,280 miles in the record time of three days and nine hours.

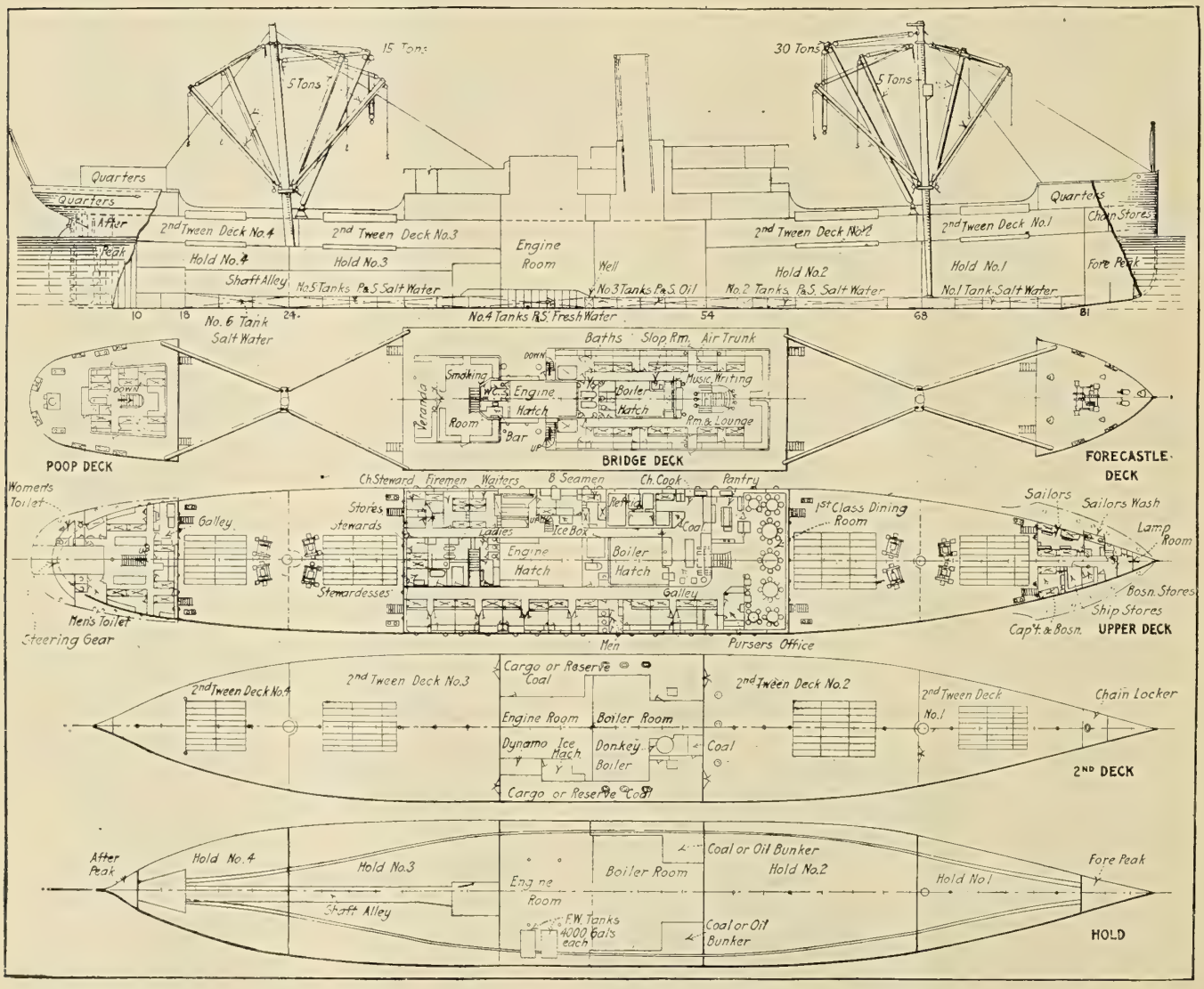


Fig. 2.—General Arrangement of the *Munamar*, Showing Profile and Deck Plans

Munson Steamship Munamar

The new Munson liner *Munamar,* recently built by the Maryland Steel Company, Sparrows Point, Md., is a steel vessel of 4,000 tons deadweight capacity built on the Isherwood system of longitudinal framing with a raised poop, forecastle and saloon deck amidships. She was designed by Theodore E. Ferris, naval architect, New York, in collaboration with the builders, and has accommodations for fifty-two first class and thirty-eight second class passengers besides a crew of sixty-four and ten officers. Her designed speed at sea is fifteen knots loaded.

The principal dimensions of the *Munamar* are as follows:

Length overall	368 feet 3 inches
Length between perpendiculars	353 feet 9 inches
Beam, molded	47 feet 3 inches
Depth, molded	27 feet 3 inches
Load draft	21 feet 1 inch

The general arrangement of the accommodations is shown on the accompanying plans. At the forward end of the midship house on the main deck is the first class dining saloon, which seats forty-eight persons. This saloon is finished in white enamel with tapestry panels, while the floor is covered with asbestolith. Aft of the dining saloon on the starboard side are twelve first class staterooms, while on the port side of the main deck amidships are quarters for the engineers. At the stern are the second class accommodations. Above on the bridge deck are fourteen first class staterooms and the first class social hall paneled in sycamore. The first class smoking room, located on the bridge deck, is paneled in quartered oak, while the floor is laid with rubber tile. Hot and cold fresh and salt water is supplied to all of the baths and toilets.

For handling cargo both the main mast and the fore mast are fitted with four five-ton and one thirty-ton cargo booms, the booms on each mast being operated by four reversible double-cylinder single drum winches.

Propulsion is by a triple expansion inverted reciprocating engine with cylinders 27¼, 46 and 78 inches diameter by 51 inches stroke, supplied with steam at 200 pounds per square inch pressure by three Scotch boilers 16 feet 6 inches diameter by 11 feet 6 inches long, equipped with White mechanical fuel oil burners. The boilers are operated on the Howden system of forced draft, the forced draft blowers being supplied by the American Blower Company.

The engine room auxiliaries include a complete outfit of Blake and Knowles pumps, two 15-kilowatt electric generating sets driven by Terry turbines, a two-ton refrigerating plant supplied by the Brunswick Refrigerating Company, a Shutte & Koerting evaporator and a Shutte & Koerting distiller of 4,000 gallons capacity. The feed water heater is of a Shutte & Koerting type, while hot water for baths is supplied by a Goubert heater made by the Griscom-Russell Company. Ventilation of the hull is by Sturtevant fans.

In service the *Munamar* has proved remarkably steady, with no perceptible vibration. From New York to Antila, Cuba, she has averaged 14½ knots on reduced revolutions from dock to dock.

Pressure on a Vessel's Bottom During Launching

BY G. H. BARBER

Before launching a vessel there are two pressures, in addition to the locally concentrated pivoting pressure, which should be carefully determined both as to location and amount. These are the pressure on the ground ways and the thrust of the packing against the shell. To ensure a successful launching, an excess of these pressures beyond a safe amount must be guarded against by the stiffening of the ground way supports and the fitting of special interior shoring in the vessel.

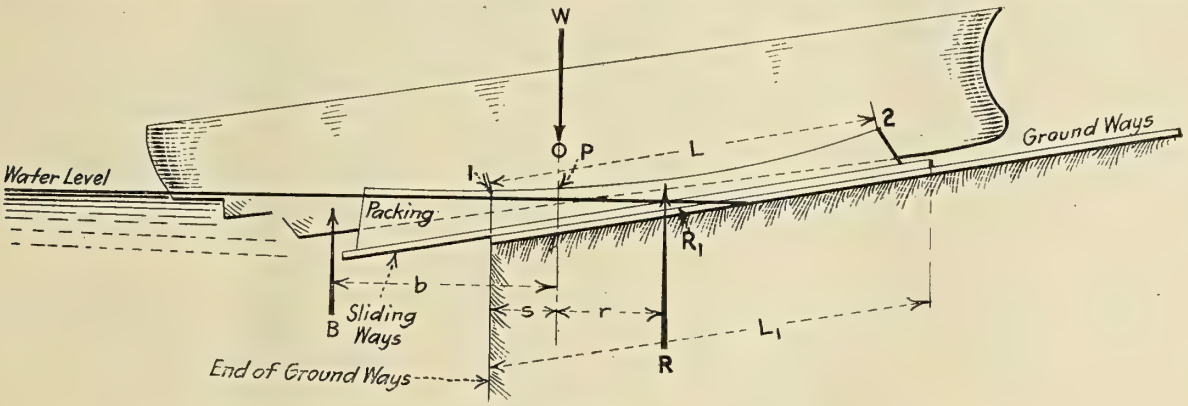


Fig. 1

The amounts of these pressures are easily obtained until the weight of the vessel commences to be taken up by the buoyancy, and until the after end of the packing passes the end of the ground ways. The pressure on the ground ways at the start is, of course, the total weight on the ways, divided by the effective area of the sliding ways. The thrust against the shell at the start may be taken, for all practical purposes, as equal to the weight of the vessel divided by the area of packing in contact with the shell.

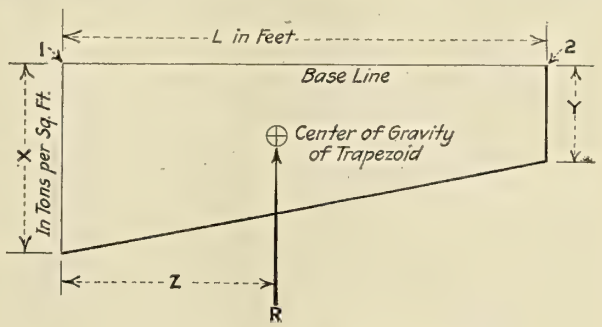


Fig. 2

It is with the maximum pressures that we are chiefly concerned. A method which gives very close results for the thrust exerted at any point of the shell in contact with

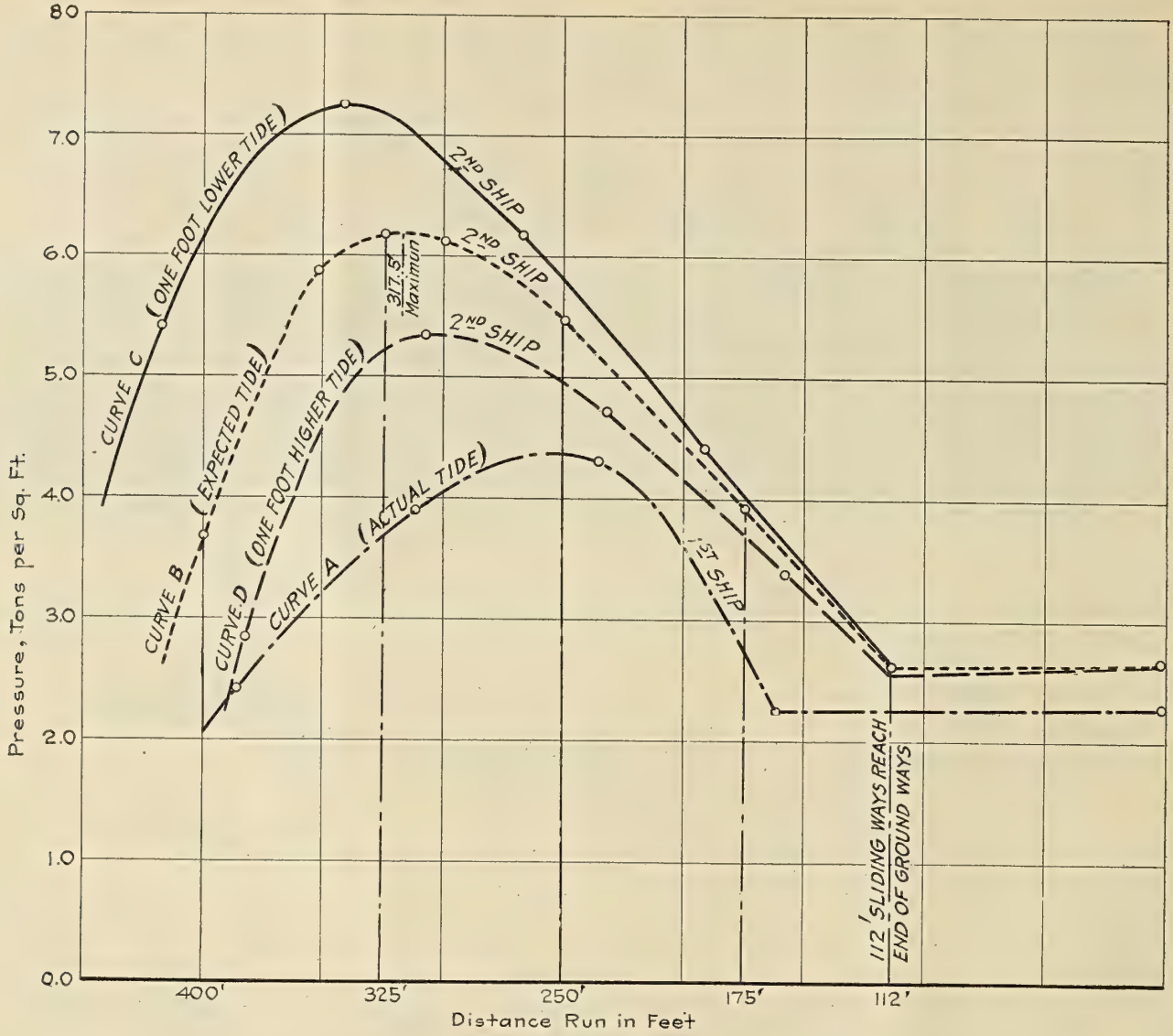


Fig. 3

the packing is given below. The pressure on the ground ways is similarly obtained, but with the additional consideration of the weight of the packing and the slight difference in the bearing area.

Fig. 1 shows the forces at work and the data required. The values for B and b are usually available from the preliminary launching calculations. If not, they can be readily worked out, and curves of buoyancy and fore-and-aft center of buoyancy plotted (see article on "Launching Calculations," in December, 1914, International Marine Engineering). The launching weight and longitudinal center of gravity of the vessel must also be calculated. The values for S and L are dependent on the run of the vessel relative to the end of the ground ways.

Referring to Fig. 1, it is evident that the pressure is greater at 1 than at 2, due to the weight of that part of the vessel overhanging the end of the ground ways, which weight is only partially supported by buoyancy. If the vessel is considered to be rigid, the pressure curve will be a straight line between the points 1 and 2. The area enclosed between this curve and its base line will be trapezoidal in shape and equal to R. R will act at the center of gravity of the trapezoid a distance Z, Fig. 2, from the left side. Z is a fixed distance equal to $s + r$, and is found as follows:

$W - B = R$. Then taking moments about the point P,

$\Sigma M = O = B \times b - R \times r$, or

$B \times b = R \times r$, and

$$r = \frac{B \times b}{R},$$

$$Z = r + s.$$

Regarding the value and direction of R, the following should be noted: The amount of weight which the packing must support equals $W - B$. This weight is supported by the normal reaction and friction of the packing against the shell. R, therefore, being the summation of the normal reactions, does not act exactly in a vertical direction, but very nearly so. For all practical purposes, R may be taken as equal to $W - B$, acting over a length L, as shown. On the other hand, when considering the pressure on the ground ways, the ground way reaction must be taken as $(W - B) \cos \theta$—which equals R_1—acting over a length equal to the effective length of sliding ways in contact with the ground ways L_1, the angle being the angle of the ground ways to the horizontal.

There is only one trapezoid which will fill the requirements of R, Z and L for a given run. Therefore, X and Y, Fig. 2, must have definite fixed values for any definitely chosen run of the ship. These values can be obtained algebraically from the two equations, which give the area

of the trapezoid, and the center of gravity of the trapezoid from its greater side, namely:

$$(1)\quad R = L\left(\frac{X+Y}{2}\right) \text{ and } (2)\quad Z = \frac{L}{3}\left(\frac{X+2Y}{X+Y}\right)$$

The values of all terms in equations (1) and (2) are now shown except those of X and Y, which are the bottom pressures at the points 1 and 2, respectively. The values of X are obtained for different runs of the vessel, and a curve plotted on distance run in feet as a base and tons per square foot as a vertical scale. To get this latter value divide the value of X as obtained above by the total width in feet of the sliding ways.

In Fig. 3 are shown curves for two battleships of different classes which were launched from the same building slip. Curve A has been plotted for actual conditions of tide and weight for the earlier ship. Curves B, C and D are for the later and larger vessel, and show the bottom pressures, which would exist for the expected height of tide and for tides one foot lower and one foot higher than the expected tide. The actual tide for the second ship was, by a rare coincidence, very nearly that which was used in the preliminary calculations, based on the expected height of tide.

The curves A and B will bring out the difference of pressures which exist between two ships due to differences in weight, length and initial position on the ways, since the height of tide for curve A was within an inch of the tide for curve D. Curves B, C and D illustrate the effect of tide on bottom pressures.

The values for curves C and D may be quickly obtained for the values of buoyancy used for curve B by substituting in the equations (1) and (2) the values of L and Z corrected for the decreased and increased distance run, respectively, to obtain this buoyancy (see previous article mentioned above).

The maximum bottom-pressure curve is of great practical value in that it shows exactly over what part of the vessel the maximum thrust is exerted. Thus is indicated the portion of the ship which must be especially stiffened in wake of the packing if the bottom pressures exceed a safe limit.

As an example, assume that it is desired to fit special shoring to take all thrust in excess of 5 tons per square foot. Referring to curve B, it is noted that the maximum pressure is exerted after a run of 317.5 feet. At the start the center of gravity of the vessel, located at frame No. 75, the frames being spaced 4 feet apart, was 352.5 feet from the end of the ground ways. Then, since $\frac{352.5 - 317.5}{4} = 9$ frames, about, the frame No. 75 was 9 frames forward of the end of ways when the maximum pressure was exerted; that is, frame No. 84 was over the end of the ground ways. A pressure of over 5 tons per square foot is exerted from the 225-foot run to the 375-foot run, or for 150 feet. The vessel must, therefore, be shored from 317.5 feet — 225 feet = 92.5 feet aft of frame No. 84 to 375 feet — 317.5 feet = 57.5 feet forward of frame No. 84, or from about frame No. 70 to about frame No. 107.

Trials of Battleship Pennsylvania.—During her standardization trials off Rockland, Me., on February 24, the new United States battleship *Pennsylvania*, built by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., attained a speed of 21.75 knots as against her contract speed of 21 knots. The average of the five runs was 21.38 knots, and on her twelve-hour run off the Virginia capes she averaged 21.05 knots in a 50-mile gale.

Conversion of the Army Transport McClellan into a Refrigerator Ship

BY F. J. FRENCH

When, in the early summer of 1914, the exigencies of the service demanded the carriage of large quantities of frozen beef and other chilled supplies from the United States to ports on the Gulf of Mexico, the quartermaster corps of the army was directed to make such alterations to one of its transports as were necessary to fit it for this purpose.

The vessel chosen for conversion was the U. S. A. transport *McClellan*, which is 321 feet waterline length by 37 feet beam and 21 feet load draft, with a maximum displacement of about 5,000 tons. The task of converting this ship in a minimum of time and at a minimum cost was allotted to the quartermaster's office at New Orleans, with Captain W. O. Smith, U. S. A., in charge of the work. The record time which was made in putting the ship into service and her satisfactory performance since reflect credit upon the department.

This ship was of English build and had formerly been fitted as a refrigerator ship, though all the evidences had been removed with the exception of a 'thwartship refrigerator room on the lower deck abaft the engine casing and a large ice machine of about twenty tons' capacity, which it was decided was beyond repairs.

In tearing out the insulation of the old ice room the steel lower deck under the entire space from engine casing to No. 3 hatch was found to be entirely rusted out. This deck was removed and new plating laid and riveted up in thirty-six hours.

The portion of the ship available for refrigerating and cooling space consisted of the 'tween decks, divided into four parts by transverse bulkheads, and four holds, the dividing bulkheads being the same as for the 'tween-deck spaces.

These spaces were known (beginning forward) as 'tween decks spaces, Nos. 1, 2, 3 and 4, and holds Nos. 1, 2, 3 and 4, and will be referred to by these numbers. The hold spaces were broken at intervals by strong beams at the orlop deck level, and a stringer plate about 30 inches wide covered the beams at their extremities. In hold No. 4 a temporary wooden deck had been laid on these beams, and this had to be removed, as well as all living quarters in the 'tween decks.

The insulating material selected was "Waterproof Lith" supplemented by "Flax Fibre" for filling the interstices between beams and frames and for packing in other places where the Lith could not be easily fitted. It was decided to utilize the 'tween spaces for carrying chilled material only and to reserve the holds for the frozen beef, fitting the latter with a greater ratio of cooling-pipe surface.

As the meat was to be received frozen hard and covered with sacking, it was considered unnecessary to fit hanger rails and hangers, and the method of storage adopted was simply to pile the cargo in layers on a floor grating of wood, with wood gratings at suitable intervals between the layers of meat. This arrangement had the advantage not only of affording greater storage space, but also of saving a very considerable sum of money, as with the alternative method it would have been necessary to fit many thousands of feet of hanger rails and also to build in a deck at the orlop deck level of sufficient strength to support its quota of beef. As the allotment of funds for this work was limited, the saving mentioned was a consideration not to be ignored.

The construction of the insulation is shown in the cross-section (Fig. 2), and is as follows:

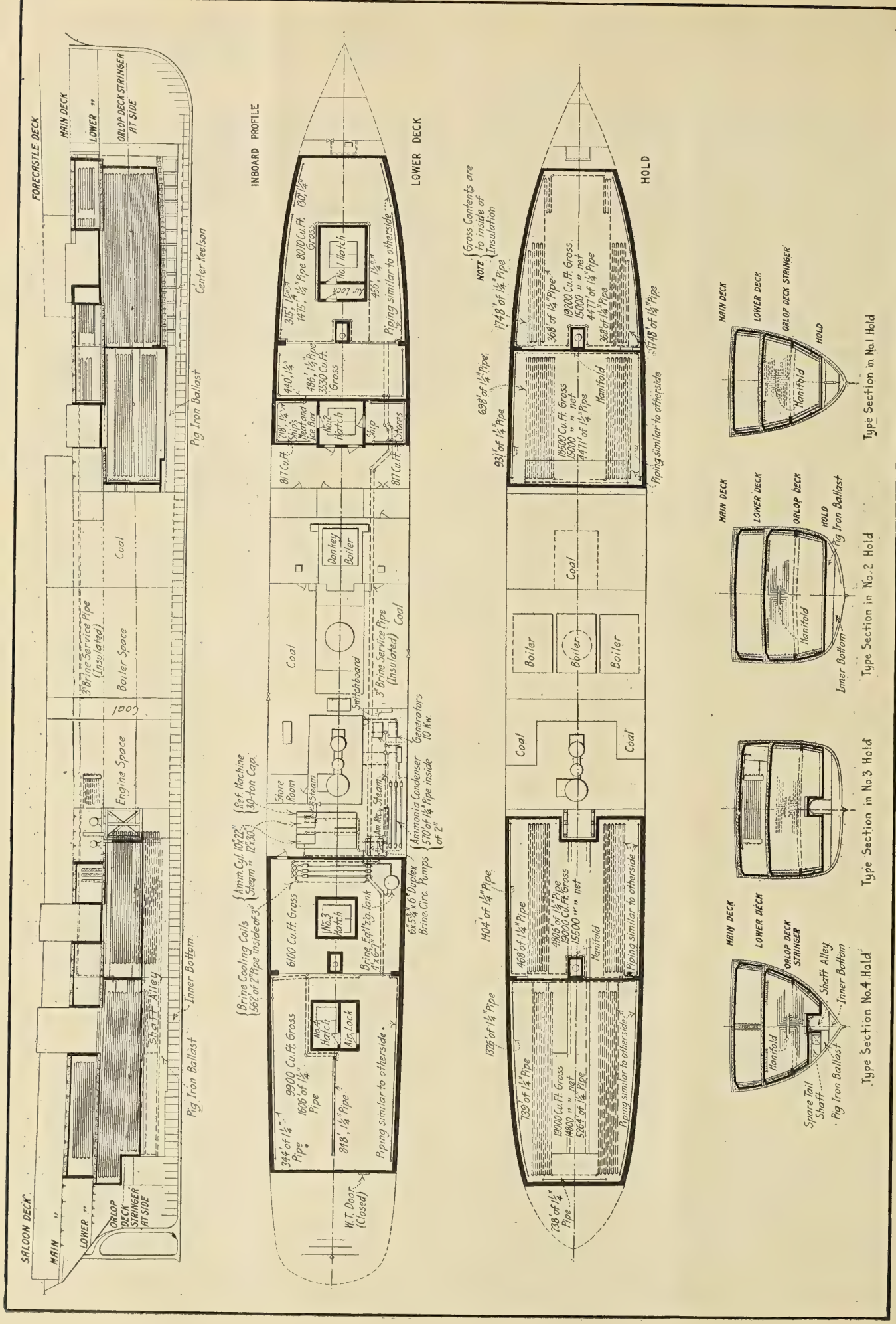


Fig. 1.—Profile, Deck Plans and Cross-Sections of the United States Army Transport, Showing Location of Refrigerator Holds and 'Tween Decks and Arrangement of Refrigerating Machinery

A 2-inch by 4-inch yellow pine stud was bolted (in suitable lengths) at head and heel to each frame. Nailed to studs was one thickness of tongued and grooved cypress sheathing. Then two layers of 90-pound roofing paper. Over the paper were placed vertical nailing strips 2 inches by 2 inches, on 20-inch centers. Between the nailing strips came the blocks of 2-inch waterproof Lith set in cement, then two more layers of paper, and finally another thickness of cypress sheathing; the inside surface of the compartment being then treated with three coats of best orange shellac.

This construction applies to the undersides of decks as

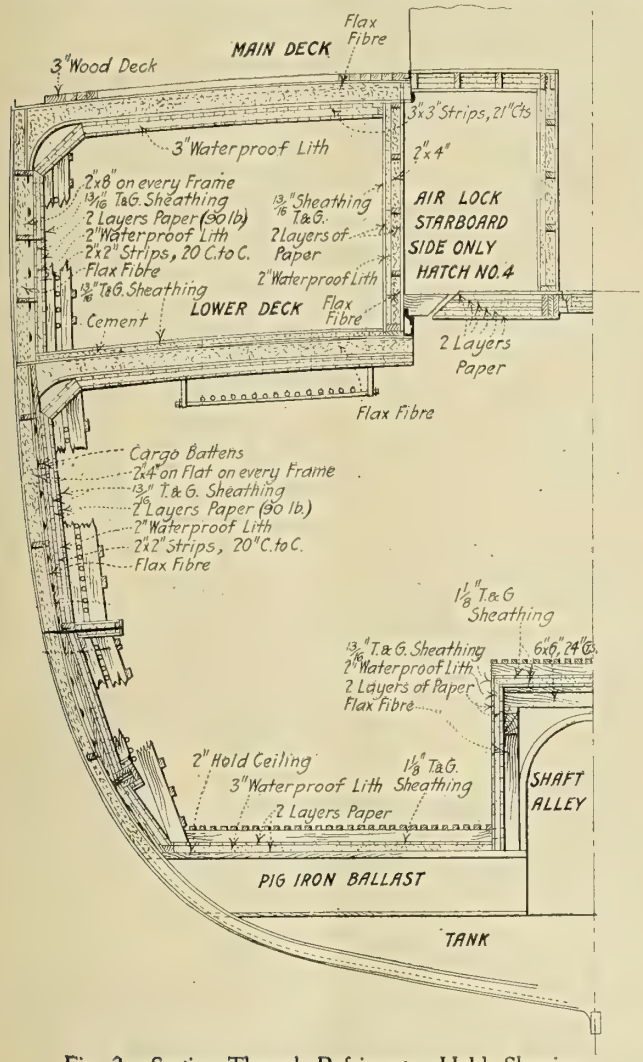


Fig. 2.—Section Through Refrigerator Hold, Showing Method of Insulation

well as to the sides of the ship. Between the wall thus formed and the decks and skin of the ship was packed Flax Fibre well tamped and supplied with spacers to prevent settling.

Under the main deck, which was to be subjected to the direct rays of a tropical sun, the thickness of the Lith was increased from 2 inches to 3 inches, and the same thickness was laid on the wood floor covering the pig iron ballast in the holds. Raised platforms or false decks were also constructed in the holds where conditions of form showed it to be expedient, and a casing was built around the shaft alley, as shown.

All hatchways were cased in and vertical and horizontal doors fitted, with air locks from the former into the 'tween-deck compartments.

The walls and ceiling of all compartments were then covered with 1¼-inch brine pipes, the total length of pipe being proportioned to the cubical contents of the compartment as given in the following table. These pipes were subdivided into groups or coils of from 500 to 600 feet in length, one end of each coil leading to the supply manifold, and the other to the suction manifold, the manifolds being placed inside the compartment on the transverse bulkhead, as near the entrance as practicable. In addition to control by the manifold valves, each compartment can be cut out from the main line. The entire system was tested out under air pressure before being filled with brine.

The brine pipes in the holds were protected from contact with the meat by aprons formed of 2-inch by 4-inch strips nailed horizontally to 4-inch by 6-inch vertical studs. The transverse steel bulkheads separating the holds were fully insulated on one side only and to lessen the heat leakage, from the skin of the ship inward into the other compartment the bare side was insulated for a width of 3 feet around the margin. The same treatment was accorded the orlop deck stringer plates, while on the bulkheads separating the 'tween-deck compartments this was the only insulation fitted, as it was not thought that it would be necessary to operate them independently of each other.

The gross volumes shown in the table are to the inside surface of the ceiling, while the net volumes are to the inside of the brine pipe aprons. The ratios of cubic feet of space per lineal foot of 1¼-inch brine pipe are based on the gross volume of the compartment, and the supply mains have been reduced to equivalent lineal feet of 1¼-inch pipe.

Compartment	Cubic Feet, Gross	Cubic Feet, Net	Lineal Feet, 1¼-In. Pipe	Ratio Cubic Feet per Lin. Ft.
'Tween decks No. 1.....	8,070	.....	1,475 }	
'Tween decks No. 2.....	3,530	.....	486 }	5.9
'Tween decks No. 3.....	6,100	*	..... }	
'Tween decks No. 4.....	9,900	.....	1,606 }	5.0
Meat and ice box.....	817	.....	218	3.75
Ship's stores	817	.....	171	4.75
Hold No. 1.....	19,200	15,000	4,477	4.30
Hold No. 2.....	18,500	15,000	4,711	3.92
Hold No. 3.....	19,000	15,500	4,806	3.94
Hold No. 4.....	19,000	14,800	5,264	3.62

* Brine-cooling coil..

The first of the two refrigerating machines—a thirty-ton machine manufactured by the Mayer Ice Machine Company—was installed in New Orleans. This company was also awarded the contract for furnishing and installing all of the brine piping. The compressor is of the horizontal type, with a single steam cylinder 12 inches diameter by 30 inches stroke, fitted with Corliss valve gear. The ammonia cylinder is 10 inches diameter by 22 inches stroke. The condenser for this machine is of the double-pipe flooded type, consisting of 570 feet of 1¼-inch pipe inside of 2-inch pipe. The brine-cooling coils are also double, and are composed of 562 feet of 2-inch pipe inside of 3-inch pipe.

Two duplex brine-circulating pumps, 6 inches by 5¾ inches by 6 inches, a brine-equalizing tank and a duplex circulating pump, 7½ inches by 5 inches by 6 inches, for the condenser complete the refrigerating equipment, which was installed at this port.

The old electric generators were removed and two new 10-kilowatt units installed, with plugs for portable lights in all compartments.

Screwed deck plates were fitted in the main deck over all compartments, and thermometers suspended from them by sash chain extending down through pipe leads. In each hold one pipe terminates below the lower deck, while a second extends to the lower portion, in order that both average and maximum temperatures may be observed.

The price bid on the insulation being considered exorbitant, the work was let out on a cost plus percentage basis

U. S. A. T. McCLELLAN REFRIGERATOR LOG, JUNE 24 TO JULY 3, 1914.

Date.	Hour.	Rev. per Mt.	Pressures.			Temperatures.													
			Brine Pressure.	Condenser Pressure.	Expansion Pressure.	Brine Cooler.	Brine Pump.	Meat Box.	Chill Box.	Tw. 3	Deck 4	1 U	B	2 U	B	3 U	B	4 U	B
June 24	8 p.m.	46	30	195	8	19	26												
" 24	10 p.m.	40	30	190	15	45	54												
" 24	11 p.m.	40	30	190	15	29	38												
" 24	12 p.m.	40	30	190	15	29	38												
" 24	4 a.m.	40	30	190	10	20	32												
" 24	6 a.m.	70	30	190	10	4	12												
" 24	8 a.m.	60	38	205	5	6	14												
" 24	9 a.m.	60	25	205	5	13	19												
" 24	12 a.m.	40	45	190	15	26	34												
" 25	2 a.m.	72	40	195	7½	4	12												
" 25	4 a.m.	70	40	195	7½	3	12												
" 25	12 a.m.	40	35	200	7½	12	18							54	39	34	27		
" 25	1 to 4 p.m.	45	30	190	12	11	18							56	48	32	26		
" 25	4 to 8 p.m.	50	30	190	10	3	30	36	45					54	39	39	27		
" 25	10.30 p.m.	48	40	190	10	13	23							56	46	38	26		
" 25	12 p.m.	72	40	190	10	14	18												
" 26	1 to 4 a.m.	48	40	175	7½	0	6							58	50	36	20		
" 26	4 to 8 a.m.	45	43	175	8	2	6	32	52					58	50	24	19		
" 26	8 to 12 a.m.	60	43	190	14	11	18							52	42	26	22		
" 26	12 to 4 p.m.	45	40	185	13	40	10	33	46										
" 26	4 to 8 p.m.	45	40	182	10	8	14							56	26	26	22		
" 26	8 to 12 p.m.	60	30	180	10	11	14							42	24	26	22		
" 27	12 to 4 a.m.													24	42	22	26		
" 27	4 to 8 a.m.	60	33	190	10	22	28							46	26	26	26		
" 27	8 to 12 a.m.	48	36	182	9	14	20							48	28	32	28		
" 27	12 to 4 p.m.	60	40	185	15	9	18	38	48					46	26	29	22		
" 27	4 to 8 p.m.	56	40	180	8	1	6	38	48					44	22	24	19		
" 27	8 to 12 p.m.	54	40	172	10	0	6							42	18	22	17		
" 28	12 to 4 a.m.	56	40	172	10	3	9							42	18	22	17		
" 28	4 to 8 a.m.	58	40	172	8	2	4							42	16	22	16		
" 28	8 to 12 a.m.	54	40	180	16	14	20	32	48					22	18	24	19	50	50
" 28	12 to 4 p.m.	60	40	180	15	10	16	38	45					24	22	26	22	34	34
" 28	4 to 8 p.m.	56	40	180	13	16	22	38	45					28	24	26	24	32	30
" 28	8 to 12 a.m.	54	42	180	12½	8	14	38	45					24	22	30	22	28	26
" 29	12 to 4 a.m.	54	45	172	13	6	12							26	22	26	20	26	24
" 29	4 to 8 a.m.	54	40	172	12½	7	12	30	45					22	20	25	20	24	22
" 29	8 to 12 a.m.	54	40	160	12	5	10	30	45					22	18	24	18	24	20
" 29	12 to 4 p.m.	58	40	145	12	4	10							20	18	24	18	20	19
" 29	4 to 8 p.m.	56	40	145	10	2	8	30	46					20	18	22	18	19	18
" 29	8 to 12 p.m.	54	45	143	10	2	8	30	46					21	17	20	16	18	16
" 30	12 to 4 a.m.	60	45	140	10	2	8							19	16	22	16	17	16
" 30	4 to 8 a.m.	80	43	140	10	2	8							17	16	20	16	17	16
" 30	8 to 12 a.m.	54	43	132	9	1	6	30	42					17	16	19	15	16	15
" 30	12 to 4 p.m.	58	45	130	10	0	6	30	44					6	14	20	14	16	14
" 30	4 to 8 p.m.	58	43	130	10	2	8	30	42	26	33			17	15	20	15	15	15
" 30	8 to 12 p.m.	72	43	130	9	0	5	30	42	24	26			16	14	18	14	14	12
July 1	12 to 4 a.m.	70	45	130	10	1	6	30	42	20	26			16	14	18	14	14	12
" 1	4 to 8 a.m.	64	43	130	8	0	6	30	44	18	24			15	12	16	12	12	12
" 1	8 to 12 a.m.	64	43	130	10	1 B	5	26	44	17	23			14	12	16	12	12	10
" 1	12 to 4 p.m.	70	45	130	8	1 B	5	26	44	17	21			14	12	12	16	12	21
" 1	4 to 8 p.m.	62	40	130	8	2 B	4			16	20			13	11	14	10	11	10
" 1	8 to 12 p.m.	70	40	125	7	3 B	3			16	18			14	12	14	12	10	8
" 2	12 to 4 a.m.	65	40	125	7½	4 B	2			14	17			12	10	11	9	10	9
" 2	4 to 8 a.m.	70	40	125	7½	4 B	2			14	16			9	8	11	9	9	8
" 2	8 to 12 a.m.	54	40	130	6	4 B	2	24	44	12	15			9	11	9	11	8	8
" 2	12 to 4 p.m.	60	40	130	6	4 B	2	24	44	12	15			11	8	11	8	8	7
" 2	4 to 8 p.m.	60	40	130	5	5 B	1			12	15			11	8	11	9	8	8
" 2	8 to 12 p.m.	56	40	125	6	5 B	1			14	17			11	8	11	10	8	8
" 3	12 to 4 p.m.	54	40	125	5	5 B	0	24	44	12	15			11	8	11	8	7	7
" 3	4 to 8 p.m.	56	40	130	5	6 B	0			10	16			11	7	7	7	6	6
" 3	8 to 12 p.m.	58	40	126	6	5 B	1	26	44	10	14			11	7	10	7	6	6

to H. L. Alexander, a New Orleans contractor, and the entire job of insulating and installing the pipes and machinery was completed in thirty days.

Upon the day of completion, the *McClellan* was ordered to New York City, where a second machine—a York 20-ton compressor—was installed; a cargo of beef was shipped, and the vessel left immediately for the Gulf of Mexico, where she has since been in continuous service. The table shows a log of the try-out on the run between New Orleans and New York.

Care of Boilers

When boilers are under steam irregulatr working should be guarded against as much as possible. The water in the boiler should occasionally be tested for acidity, which can be easily done by means of a slip of litmus paper dipped in the salinometer. In cases where water losses are necessarily made up from the sea, blowing, except for the purpose of scumming, should not commence until a saturation of from 3 to 3½ is reached, the surface blow being preferably used for this purpose when steaming, and the bottom blow when under low-banked fires. When through steaming no haste should be used in reducing the boiler pressure, but the steam should be allowed to work off gradually through bleeders or evaporators, the dampers should be nearly closed, only leaving enough open to allow the escape of gas, and furnace doors open. After fires are hauled care should be taken to wet them down only after being removed from the boiler front. An excellent protection is afforded by a light plate of iron fitted in front of the ash pits. The furnaces should finally be closed and the boilers allowed to cool gradually. In case it is necessary to blow the boiler down instead of pumping it out when cold, the pressure should be allowed to drop to about 20 pounds, depending upon circumstances, thereby avoiding the severe jar liable with higher pressures. In case of jar it may frequently be checked by either opening or closing the blow valve slightly.

Steam gages on boilers should be tested at intervals to see that they are adjusted correctly, as it frequently happens that gages on different boilers, all connected up, show a variance of from 1 to 10 pounds.

Costly Congestion at Marine Terminals

Antiquated Facilities and Poor Delivery Systems Boost Costs of Handling Freight at Docks—Remedies Suggested

BY A. JACKSON MARSHALL*

Freight congestion at the terminals and steamship piers of all our large cities, and especially New York, has become a very knotty problem during the past year, and we are hearing a great deal about the chaotic condition into which freight distribution, both domestic and foreign, has fallen. The reason for the unusual congestion of marine terminals just at this time is, of course, obvious when we consider that approximately 1,000 vessels, of which a large proportion were merchant steamers, with an estimated tonnage of 2,000,000 tons, have been destroyed, directly or indirectly, as a result of the European war, while in addition to this are the great numbers ot vessels which have been taken for transport service or have been interned. At present over one million tons of freight are stalled at New York terminals, and steamship piers in all of our seaport cities are stacked to the roof beams with freight intended for distribution. The shortage of ocean tonnage makes it difficult to take care of even the ordinary trade, while the added facilities demanded by bumper crops, the movement of war material and increased exports are greater than present conditions can supply, and the result is this great accumulation of freight at marine terminals.

Delay of Vessels in Port

While the shortage of ocean carriers is the major reason for present conditions, a great deal of the congestion would be considerably relieved if freight were handled in a more efficient manner at the terminals. Because of old-fashioned methods, antiquated handling facilities and confused schedules, steamers are delayed for long periods. Vessels can be rapidly loaded if cargoes are delivered properly and if they can pass through the terminals with a minimum amount of delay. With the present lack of system and inefficient handling of freight this is utterly impossible. Mr. C. H. Betts, manager of the Australian department of French, Eddye & Company, regards the shortage of pier facilities and the poor methods of moving freight in terminals as the most serious problem in connection with the commerce of our harbors. The export freight situation has become so serious that some cargoes, which should have been moved over two months ago, have not yet been tendered for shipment.

Not only has export trade been affected by the congested condition of our terminals, but domestic transportation suffers as well. Shortage of ocean tonnage is not responsible for the fact that local merchants are unable to get their goods through the terminals. It is estimated that there is a total of 720,000,000 tons of goods every year that passes through the railroad freight and transfer stations of this country, and 600,000,000 tons handled at marine terminals, making a grand total of 1,320,000,000 tons of freight handled annually in the United States, or 4,400,000 tons every working day in the year. The present lack of system in handling this freight and the tremendous amount of lost time involved represents a yearly loss of more than $80,000,000 (£16,400,000) at railway terminals alone. We pay $2,000,000,000 (£410,000,000) a year in the United States for freight transportation, four-fifths of which, or about $1,600,000,000 (£328,000,000), is for terminal work.

The fact that drayage and terminal expenses of freight transportation are 22 percent more than the line haulage of the same freight over 1,000 miles of railroad is a condition toward which every effort should be exerted to remedy. No one thing alone can solve the problem. In the first place, co-operation between railroads, steamship companies, trucking concerns, manufacturers and the public itself is vital. Certain it is that, as surely as it is a problem in transportation, improved transportation appliances, when once established through the united efforts of everyone interested, will work its solution. In the forerank among these appliances stand the commercial vehicle, the electric industrial truck, overhead telpherage systems of freight movement, the gravity conveyor, etc. As the connecting link between the terminal and the merchant, the motor truck must assume the first position among transportation facilities.

Savings with "Electric Stevedores"

In places where some modern equipment has been installed, such as the electric industrial truck, a more systematic condition has resulted and a considerable economy been effected. In the railway terminals where the electrically propelled baggage truck has supplanted the hand truck, it is estimated that there is a total saving of 66 percent. Down in Savannah, where the "electric stevedore" has been in use for some time, you may see cotton moved across great piers by these little electric trucks equipped with hoists and cranes, carrying it directly into the holds of the steamers which bring it North. Two of these electric industrial trucks would handle more cotton in one day than twenty freight handlers with hand trucks.

Under the method of hand-truck operation, the cost per ton of handling freight at railroad terminals and steamship piers is 25 cents (1/0½), while the cost per ton for performing the same work with electric industrial trucks is but 10⅓ cents (0/5 1/6).

As the use of the "electric stevedore" increases and other modern methods and appliances are installed it is to be hoped that this will influence a further systematized manner of delivery. As this work becomes more thoroughly unified, freight sheds and docks may find it desirable to operate on a full or partial 24-hour schedule. In cases where the limited ground space available in our city terminals prevents the installation of mechanical carriers that would bring about economy and efficiency, the remedy which appears most feasible to the writer is the establishing of large outer platforms or warehouses where all outbound package freight could be assembled and consolidated, and where the floor movement would be performed by the electric industrial trucks. If the co-ordination of the railroad and highway movement of merchandise and a collaboration of the railroads and teaming interests could be effected, there is every reason to believe that a powerful and efficient trucking organization could be formed which would effect not only an enormous saving over present cost, but render greatly improved service through the employment of scientific and efficient methods of operation and a truck-despatching system worked out along the same lines as is the train-dispatching and car-distribution systems of our railroads.

* Secretary Electric Vehicle Association of America, 29 West Thirty-ninth street, New York City.

It is of interest to realize that the railroad and steamship companies, in adopting or promoting some such scheme, would in all probability use electric trucks as the transportation medium. Since much freight would be conveyed at night, either to the big wholesale houses or to well-located centers, from which points goods could be advantageously distributed the following day, a vehicle operating as noiselessly as possible would be required. Owing to its practically silent operation, the electric vehicle would be ideal for traversing city streets at night, since they would not be obtrusive in passing through the residential districts. Furthermore, the recognized economy of the electric truck for city use and its absolute dependability are points in its favor for a service of this kind. Electrics are free from the unsanitary and objectionable features attached to the horse and gasoline (petrol) vehicles, and it is interesting to note that, while gasoline is expensive and the price is still soaring, electricity is constantly becoming cheaper. Moreover, there is not associated with the electric the ever-present fire hazard of the gasoline machine.

An efficient and well-regulated trucking organization would, without doubt, establish central clearing stations such as have been described, at convenient points in the business districts, to which light-capacity vehicles could be run from nearby warehouses, and from which consolidated loads could be moved in high-capacity trucks to the railroad and steamship terminals, bringing back on their return similar heavy loads of inward freight for redistribution from the central clearing house. Thus there would be secured substantially an extension of the railroad and steamship operation methods beyond the terminals. Warehouse to warehouse delivery is successfully carried on in Europe, and from the fact that over 60 percent of freight haulage in our large cities is done under contract with truckmen, it is evident that the business world in general would welcome an improvement along these lines. Confusion or congestion in freight terminals reacts throughout the entire transportation line using that terminal, hence it is safe to suppose that the solution of terminal freight congestion lies along the lines of improved street transportation by the trucking industries, through consolidation and through the use of an efficient, modern carrier—the motor truck. But, in order to secure maximum efficiency, order must be brought out of chaos, and the delivering, handling and receiving of freight at terminals must be organized at least as systematically as the railroads and steamship companies handle freight while in transit. The high point of efficiency to which the steamship companies and railroads have developed their systems of line transportation stands out prominently and most favorably when contrasted with the unorganized and disordered conditions at present existing in terminal freight handling. A development of such far-reaching influence must sooner or later attract the best minds—then we can hope for action.

Freeboard: its Preliminary Determination

Type of Ship—Dimensions—Mean Sheer—Round of Beam—Description of Deck—Coefficient of Fineness

BY H. A. EVERETT *

Freeboard is the term given to the height that the vessel's deck at the side is above the surface of the water. In the early days of steamships, overloading was common, and in order to prevent the dangerous overloading of vessels there were early legislative acts which required that certain marks should be plainly shown on the sides of the vessels below which it should be illegal to immerse the boat.

Up to 1876 there had been practically no legislative action, but at about this time the British Parliament required a mark as above stated, which, however, was affixed by the owners, and its location was dependent entirely upon the owner's judgment. For this reason the mark had but slight effect in minimizing the evil and in 1882 Lloyds issued tables in which they carefully worked out proper freeboards for different vessels which were largely adopted by the owners. The following year the British Board of Trade appointed a committee to investigate the question thoroughly, and this committee eventually drew up tables which were ultimately embodied in the Merchant Shipping Act of 1890, which may be considered as the basis of the present practice. This act is still in effect, though slightly modified in 1906 and 1909.

The basic principle of these rules is that it is desirable for a vessel to be loaded no deeper than will leave a margin or reserve of buoyancy which shall be sufficient quickly to raise the boat over seas rather than to allow the seas to come on board—in other words, that the vessel shall be sufficiently lively to be seaworthy. Indirectly, the freeboard is associated with structural strength, as a vessel which is deficient in strength should not be permitted to load as deeply and encounter such severe stresses as one which is stronger structurally. The ability of a ship to rise and not take on water is a function of the amount and location of her reserve of buoyancy.

In assigning freeboard, vessels are divided into four classes:

1. Full scantling steamers.
2. Spar deck steamers.
3. Awning deck steamers.
4. Sailing vessels.

Since the revision of Lloyds' "Rules for the Construction of Steel Vessels" in 1909, this organization has officially sanctioned by two classes of steamers, viz., full scantling and shelter deck, but the freeboard rules still hold to the classes given above with modifications for the shelter-deckers, as will be shown later. The full scantling vessel is taken as of sufficient strength, and is the standard by which strength is gaged. Vessels which are less strong are required to have more freeboard. For the full scantling vessel the freeboard is determined solely by the desirable reserve of buoyancy.

For a given ship belonging to either of the classes 1 and 3, the exact freeboard required may be calculated by constructing a displacement scale to the height of the deck to which the freeboard is measured, so as to give the whole molded volume up to the upper surface of that deck. The percentage of the total volume which is given on Plate I as a reserve of buoyancy for a vessel of given type and dimensions will be the amount of volume that must be

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left out of the water. If a line be drawn upon this displacement curve at a draft sufficient to cut off the given percentage of total volume, the height of side above this draft will be the freeboard required. (See Fig. 1.)

In order to simplify and reduce the work that would be involved by the above mode of determining the maximum allowable draft and the consequent freeboard that corresponds to a given percentage of reserve buoyancy, tables were evolved which, for a ship that conformed to a so-called standard ship, gave directly the percentages of reserve of buoyancy and freeboards necessary for different sizes and types of vessel. The curves of Plates II and III are plotted from these tables.

The *"standard ship"* was considered to be a flush deck ship with a certain sheer which was termed "standard or normal sheer," with a certain proportion of length to depth

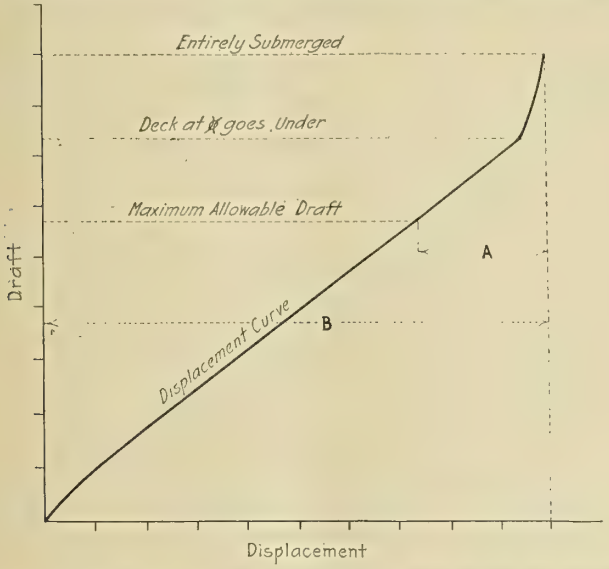


Fig. 1.—When A is the Percentage of B given by the curves on Plate I, then the Draft is the Maximum Permitted and Depth—Draft=Freeboard

and with a "standard" roundup of deck beams, and for this vessel the curves read directly. Deck erections, of course, contribute to safety and are taken account of as a corrective term, as are also other variations from the standard ship. In practice the freeboard is actually assigned to the ship after the ship is built and usually by one of the classification societies' agents, but its preliminary determination is an important and necessary item in the design of any vessel, as the draft plus the freeboard gives the depth.

The complete tables as issued by the British Board of Trade take up all of the possible modifications and corrections which are involved by vessels differing from the arbitrarily assumed standard. The following work is based upon the rules directly, although the presentation and the wording are modified to a large extent. The curves given on Plates I-IV are a graphical representation of corresponding tables in the rules. Spar deck steamers and sailing vessels are not included, as those classes are not numerous in present-day new designs.*

The limitations of loading, as laid down by the above mentioned act, are represented by a disk and number of horizontal lines called "maximum load lines" which are cut and painted on the side of the ship amidships, as shown by Fig. 2. The upper edge of each line is the point of measurement.

* For further information in this respect and for details of other elements not dealt with here, refer to the publication of the Marine Department of the British Board of Trade, issued in May, 1909, entitled "Instructions to Surveyors, Load Line," available at Wyman & Sons, Ltd., Fetter Lane, London, E. C.

The word freeboard, legally, denotes the height of a side of the ship above the waterline, measured at the middle of her length along the load waterline. It is measured from the top of the deck at the side. The reserve of buoyancy necessary for flush deck steamers of full scantling and awning deck steamers are given by the curves on Plate I, and these curves hold for any and every vessel, regardless of proportions. For the *standard* vessel of these classes and within the dimensions given the *freeboards* required may be *read directly* from Plates II and III.

For awning deck vessels the freeboards are determined more by considerations of structural strength than by reserve of buoyancy, and indicate the depth of loading beyond which it is probable that first-class vessels of this type would be unduly stressed when at sea. Therefore the freeboards and percentages of reserve buoyancy are

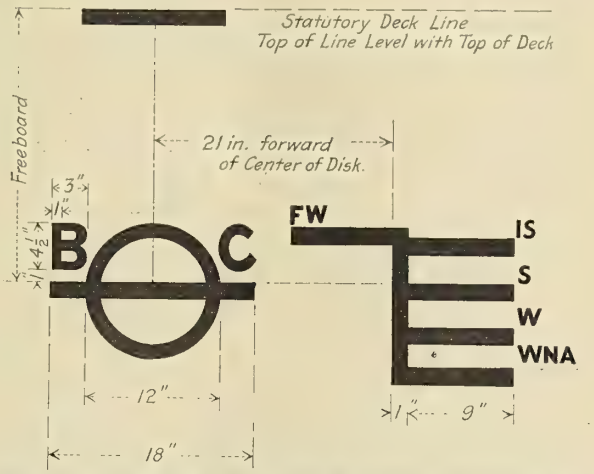


Fig. 2.—The Letters B. C. signify British Corporation*; F. W., Fresh Water Allowance; I. S., Freeboard in the Indian Seas in Summer; S., Summer Freeboard; W., Winter Freeboard; W. N. A., Winter, North Atlantic Freeboard

in *excess* of what would be required for full scantling vessels. They are measured to the *deck below* the shelter or awning deck. The freeboards given in the curves are for flush deck vessels in all cases and for the standard ship—a ship which has no deck erections, has a proportion of length to depth of 12, has a roundup of deck beams of ¼ inch per foot of beam, and has a mean sheer in accordance with that derived from the curves shown on Plate IV.

The data which are required for determining the freeboard by the curves are:

1. Type of ship.
2. Dimensions.
3. Mean sheer.
4. Round of beam.
5. Description of deck (where statutory deck line is placed).
6. Coefficient of fineness.

The *type* of ship must be agreed upon in order to ascertain which table will meet the case and whether modifications are necessary.

The *length* for freeboard of the vessel is measured at the load line from the fore side of the stem to the after side of the sternpost in sailing ships, and the after post in steamers.

The *breadth* for freeboard is the extreme breadth measured to the outside of plank or plating as given on the certificate of the ship's registry.

The *depth* for freeboard is the depth of hold as given

* Or L. R. for Lloyds Register, and B. V. for Bureau Veritas.

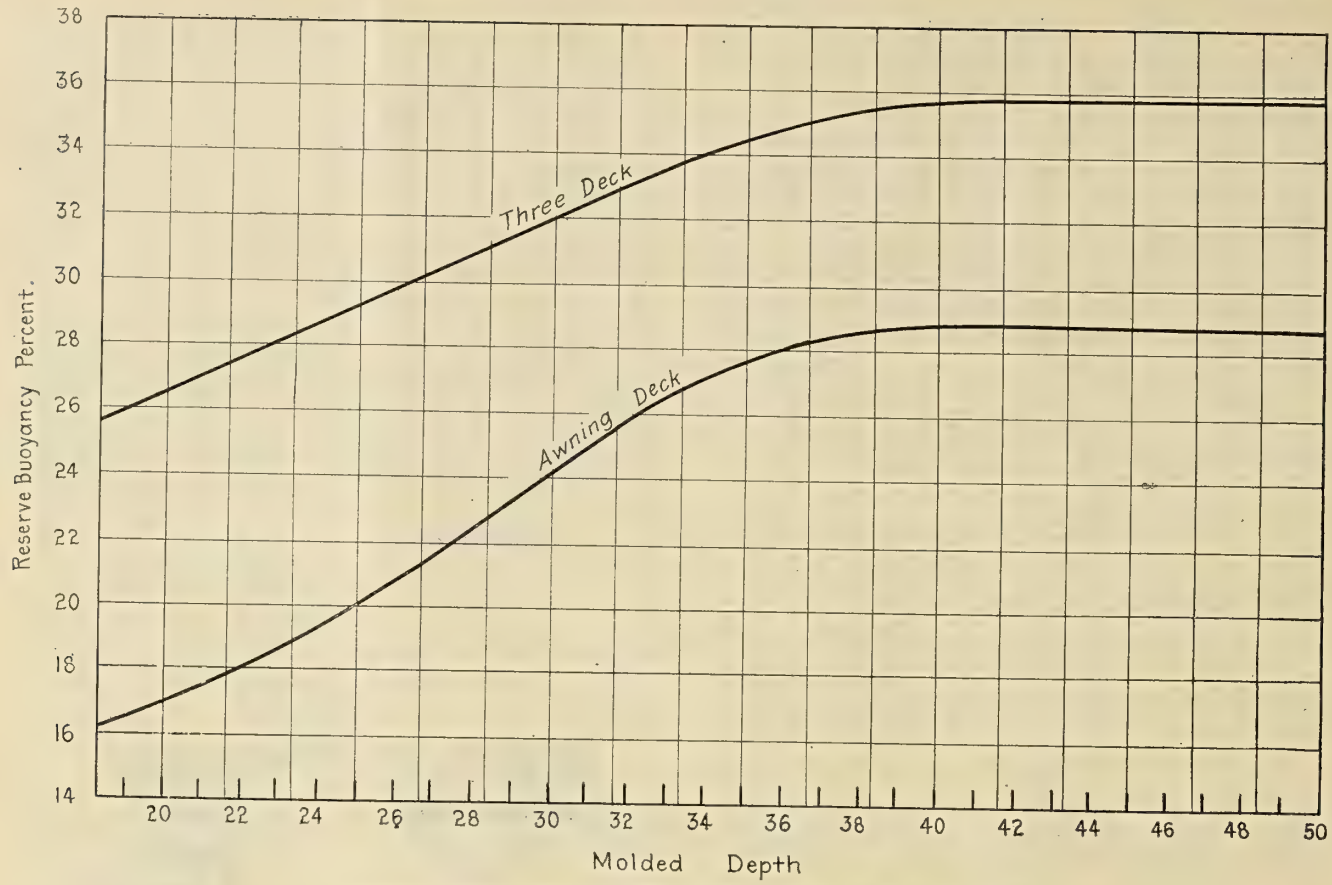


Plate I.—Reserve Buoyancy (Winter) Required by the Board of Trade

on the certificate of the ship's registry. This is the depth used for determining the coefficient of fineness. (Upper deck beam at side in flush deck vessel, main deck beam at side in spar and awning deck vessels to top of ceiling or sheathing on double bottom.)

Coefficient of Fineness

The coefficient of fineness in one, two and three-deck vessels is found by dividing one hundred times the gross registered tonnage of the vessel below the upper deck by the product of the length, breadth and depth of hold. In shelter deck vessels the registered depth and tonnage are taken to the deck below the shelter deck.

Molded Depth

The molded depth of an iron or steel vessel, as used in the curves, is the perpendicular depth taken from the top of the upper deck beam at side, at the middle of the length of the vessel, to the top of the keel and the bottom of the frame at the middle line. This is the depth which is used for the proportion of length to depth.

Freeboard

The molded depth, taken as above described, is that used in the curves for ascertaining the amount of reserve buoyancy and corresponding freeboard in vessels having a wooden deck, and the freeboard is measured from the top of the wood deck at side, at the middle of the length of the vessel. Where wood decks are not fitted on the upper decks, the freeboard should be reduced by the thickness of the wood deck or the percentage of it corresponding to the percentage of the length covered by substantial deck erections if they cover less than 70 percent.

The following example will illustrate the application of the curves when dealing with a "standard" vessel:

In a steamer of the following dimensions, viz.: length, 357 feet; extreme breadth, 40 feet; depth of hold, 26 feet; registered tonnage under deck, 2,980 tons, and *molded* depth, 29.8 feet, the under deck capacity in cubic feet is 298,000; by dividing this by 382,000—that is, the product of the length, breadth and depth of hold—the quotient is 0.78, or the coefficient of fineness.

If we now refer to Plate II at 29.75 feet molded depth and coefficient 0.78, the winter freeboard given for a *standard steam vessel* (without erections and length twelve times the molded depth) is 7 feet 7 inches, which corresponds to a reserve buoyancy of 32 percent of the total bulk.

It is obvious from the foregoing that the determination of the freeboard for a standard vessel is extremely simple. As a matter of fact, however, vessels rarely conform to the proportions assumed for the "standard," and the correct determination of freeboard for the actual vessel becomes a matter of properly applying the corrections to allow for the departure from the standard. The variations most commonly met with are in the sheer, deck erection and proportions of length to depth. The corrections for each of these items must be made and in the order given, as the correction for erections is based upon the difference between the freeboard for full scantling vessels *corrected for sheer* and the freeboard for awning deck vessels (uncorrected).

Sheer

The tables are framed for vessels having a mean sheer of deck *measured at the side,* as shown in the sheer diagram of Plate IV.

In flush-deck vessels and in vessels with erections on deck, when the sheer of deck is greater or less than the above, *and is of a gradual character,* divide the difference in inches between it and the mean sheer provided for by 4, and the result in inches is the amount by which the

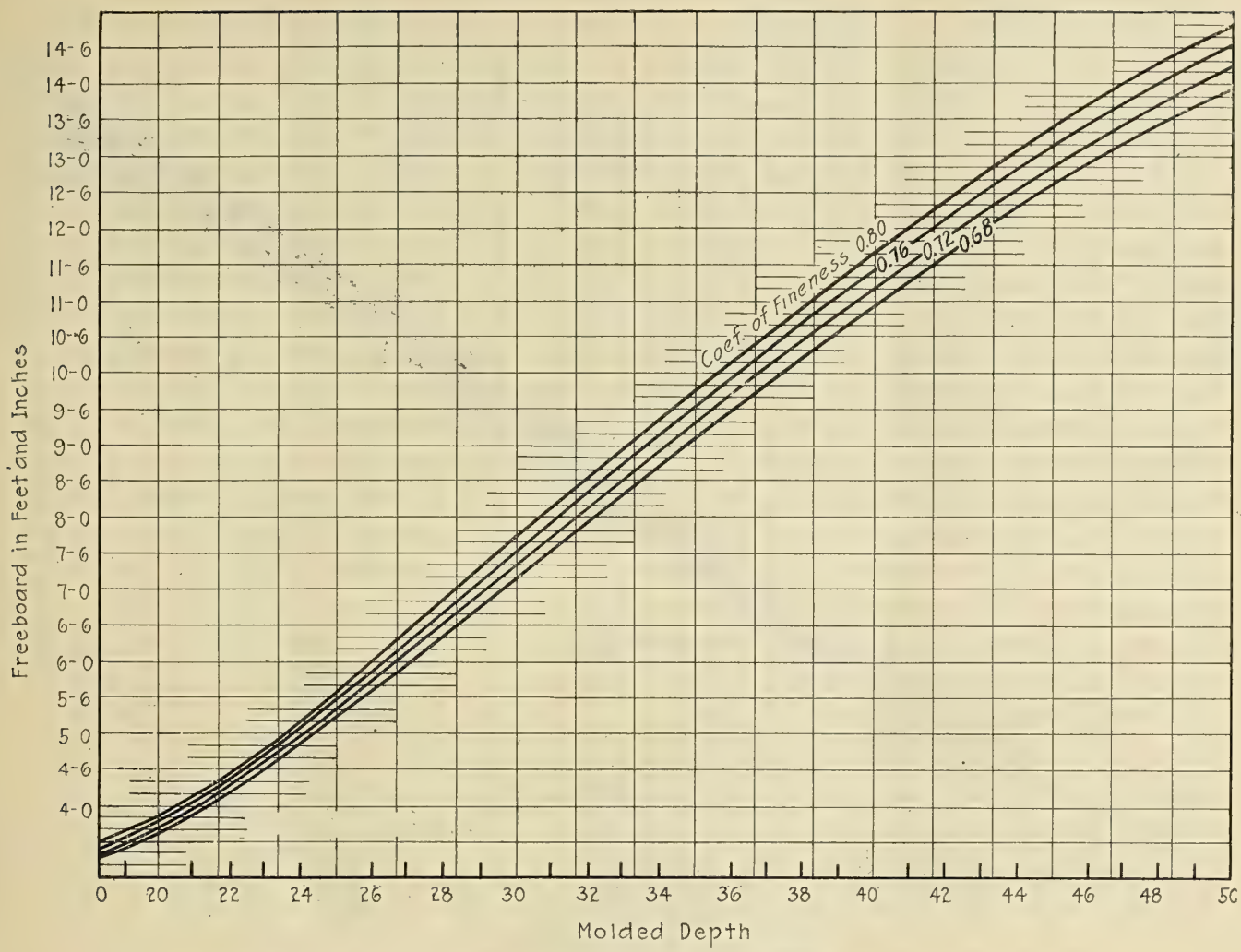


Plate II.—Minimum Freeboard (Winter) Allowed by the Board of Trade for Three Deck Steamers

freeboard amidships should be diminished or increased, according as the sheer is greater or less.

In all cases the rise in sheer forward and aft is measured with reference to the deck at the middle of the length, and where the lowest point of the sheer is abaft the middle of the length, one-half of the difference between the sheer amidships and the lowest point should be added to the freeboard specified in the tables for flush-deck vessels and for vessels having short poops and forecastles only.

Erections on Deck

For steam vessels with topgallant forecastles having long poops, or raised quarter decks *connected* with bridge houses, covering in the engine and boiler openings, the latter being entered from the top and having an efficiently constructed iron bulkhead at the fore end, a deduction may be made from the freeboard given in the curves, according to curve *A*, Plate IV.

When the erections on a vessel consist of a topgallant forecastle, a short poop having an efficient bulkhead and bridge house *disconnected,* the latter in steamers covering the engine and boiler openings, and being efficiently enclosed with an iron bulkhead at each end, a deduction may be made from the freeboard given in the curves, according to curve *B*, Plate IV.

When the erections on a vessel consist of a topgallant forecastle and bridge house only, the latter in steamers covering the engine and boiler openings, and being efficiently enclosed with an iron bulkhead at each end, a deduction may be made from the freeboard given in the curves according to curve *C*, Plate IV.

When the erections on a steam vessel consist of a short poop or raised quarter-deck of a height from 3 feet to 6 feet for lengths of ship of 250 feet to 400 feet, and topgallant forecastle only, the former being enclosed at the fore end with an efficient bulkhead, and when the engine and boiler openings are entirely covered, a deduction may be made from the freeboard given in the curves according to curve *D*, Plate IV.

Vessels of Extreme Proportions

For vessels whose length is greater or less than twelve times the molded depth for which the curves are framed, the freeboard should be increased or diminished as specified in the following table. Thus, if the vessel in the above example were 367 feet long, the winter freeboard

TABLE I.

Correction in Insurance for a Change of 10 Feet in Length.	Molded Depth, Feet.	Length, Feet.
1.2	20—23	240—276
1.3	23½—25½	282—306
1.4	26—28	312—336
1.5	28½—30½	342—366
1.6	31—33	372—396
1.7	33½—50	402—600

For shelter deck vessels the correction is one-half that specified in the above table.

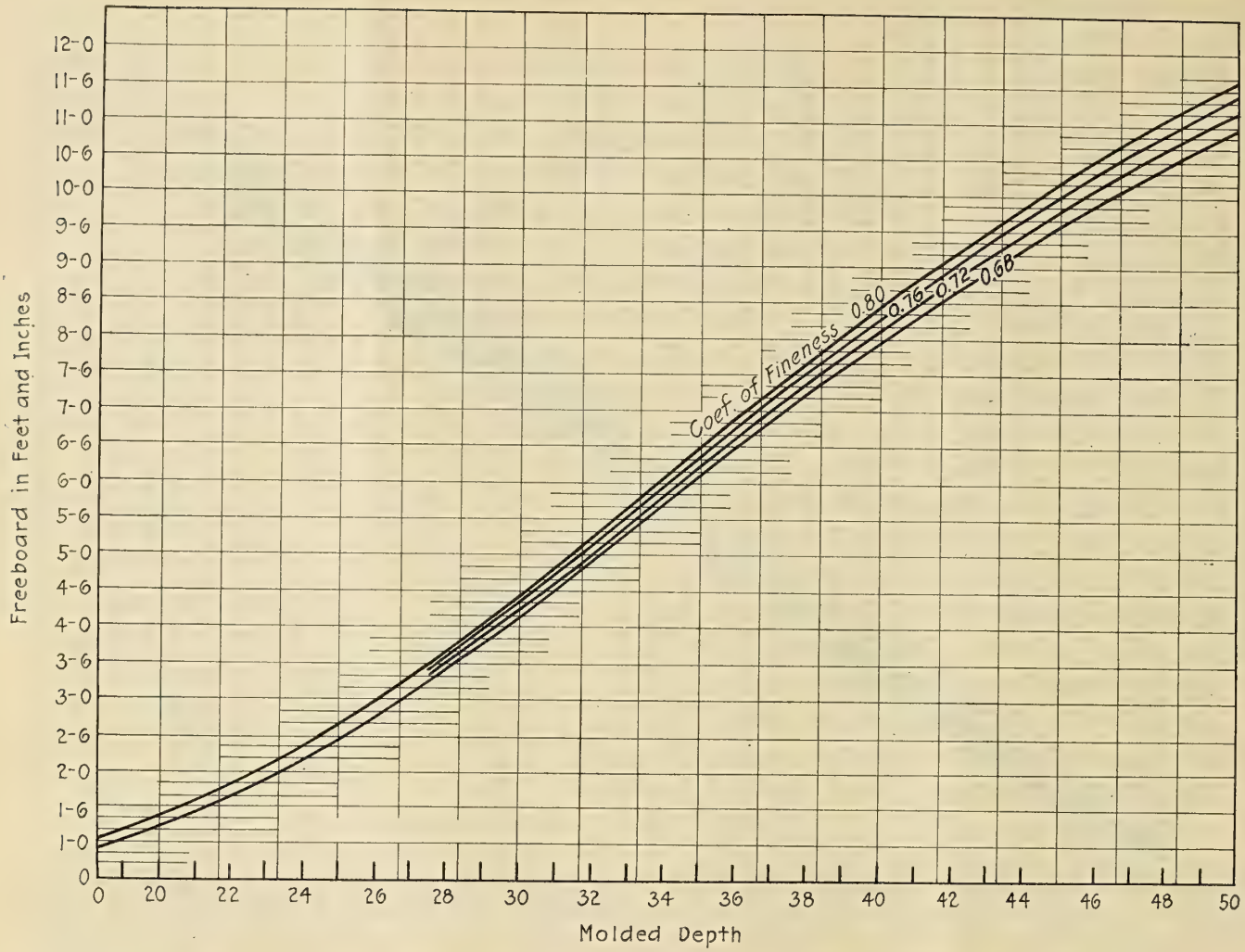


Plate III.—Minimum Freeboard (Winter) Allowed by the Board of Trade for Awning Deck Steamers

required would be 7 feet 7 inches plus 1.5 inches, or 7 feet 8.5 inches. For steam vessels with normal enclosed deck erections, as on Plate IV (curve *A* and *B*), extending over 6/10 or more of the length of the vessel, the correction for length should be one-half that specified in the plot.

Round of Beam

In calculating the reserve of buoyancy, an allowance has been made of ¼ inch for every foot of the length of the midship beam for the roundup. When the round of the beam in flush-decked vessels is greater or less than given by this rule, divide the difference in inches by 2 and diminish or increase the freeboard by this amount. For vessels with erections on deck the amount of the allowance should depend on the extent of the main deck uncovered. This rule for round of beam does not apply to shelter or awning deck vessels.

Breadth and Depth

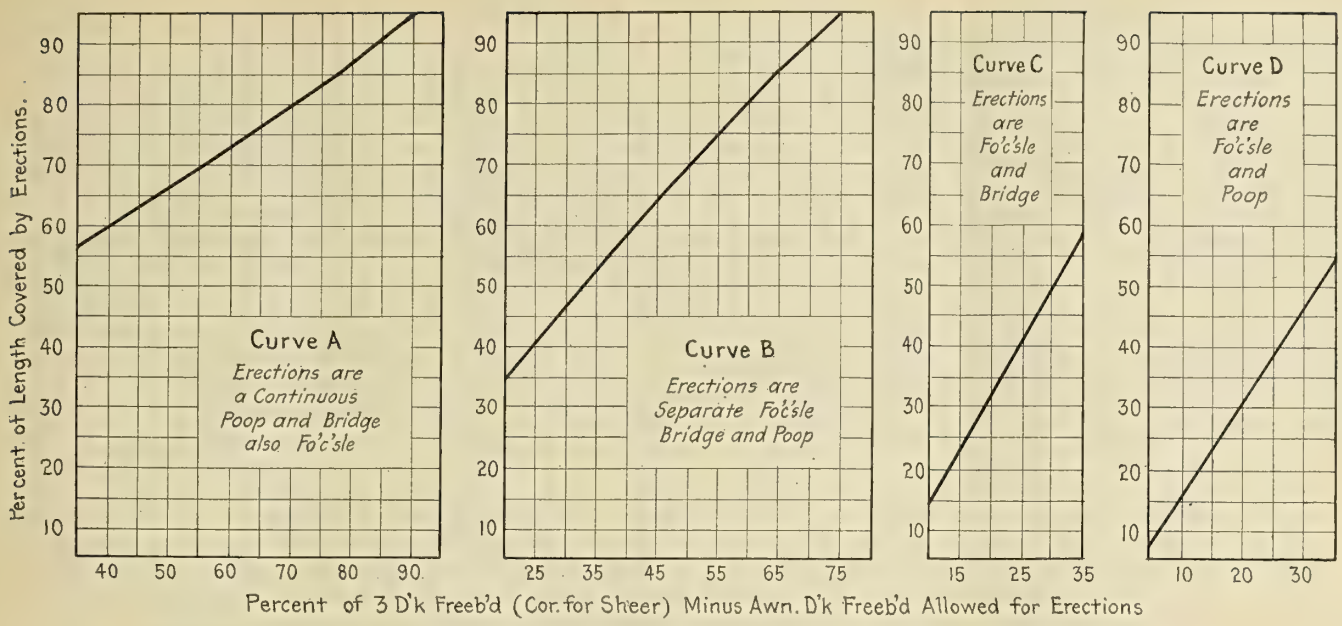
It has been assumed that the relation between the breadth and depth is reasonable, and for vessels of less relative breadth the freeboard should be increased to provide a sufficient range of stability. The following example will illustrate the application of the curves when dealing with a vessel not conforming to the standard type:

A vessel is 234 feet long, 29 feet broad and has a molded depth of 17 feet, the coefficient of fineness being .72. Suppose the vessel to have a poop and bridge house of the united length of 121 feet and a forecastle 20 feet in length, and let the sheer forward, measured at the side, be 4 feet 6 inches, and aft 2 feet 1 inch.

	Ft.	In.
Freeboard by Plate II, if of the standard proportions, without erections, and with the normal amount of sheer	2	11
The mean sheer by rule is 33.4 inches, or 6 inches less than that in the vessel, and the reduction in freeboard is 6 inches divided by 4	0	1½
Freeboard of vessel without erections and with 39½ inches mean sheer	2	9½
Freeboard by Plate III as awning-decked	0	9½
Difference	2	0

The combined length of the erections is 141/234, or six-tenths of the length of the vessel, and the allowance for erections from curve *A*, Plate IV, will be, therefore, four-tenths of 24 inches, or 9½ inches. We have therefore

	Deduct Inches
Amount deducted from freeboard for excess of sheer	1½
Amount deducted from the freeboard for erections	9½
Amount deducted if vessel be fitted with an uncovered iron main deck = 6/10 × 3½	2
	13
The length being 30 feet in excess of that for which the tables are framed, the addition to the freeboard in respect of the same is one-half of 30/10 of 1.1 inches, or	1½
	11½



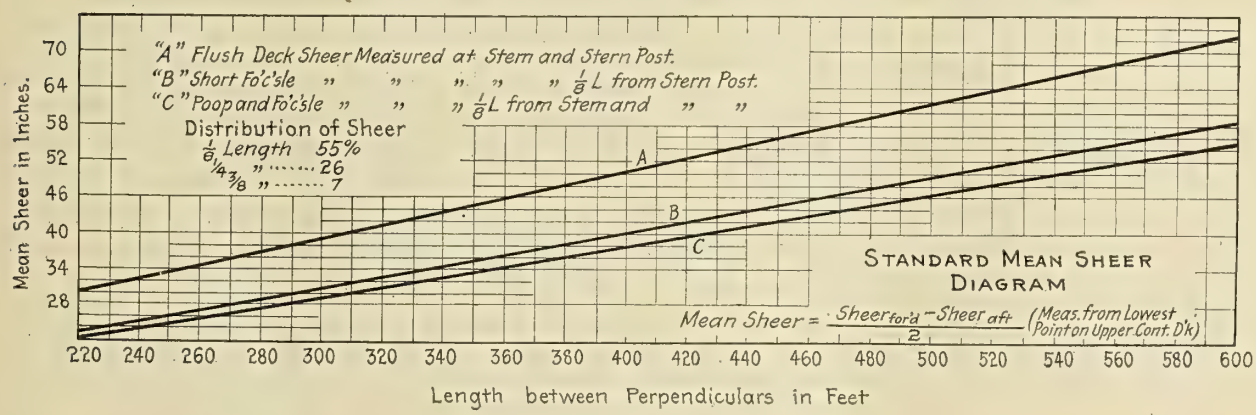


Plate IV

That is 11½ inches to be deducted from 2 feet 11 inches, leaving a winter freeboard of 1 foot 11½ inches.

Corresponding summer freeboard, 1 foot 9 inches.

Vessels loaded in fresh water may have less freeboard than that given in the several tables, according to the following scale:

TABLE II.

Molded Depth, in Feet.	Reduction in Freeboard.	
	Vessels Without Erections on Deck.	Shelter and Awning Deck Vessels.
19 and under 22	4	4½
22 " " 25	4½	5
25 " " 28	5	5½
28 " " 31	5½	6
31 " " 34	6	6½

Note.—The weight of a cubic foot of salt water is taken, in the above table, to be 64 pounds and that of fresh water 62.5 pounds.

In no case shall the deepest loadline in salt water, whether indicating the summer or Indian summer line, be assigned at a higher position than the intersection of the top of the upper deck with the vessel's side, at the *lowest* part of the deck.

In the case of shelter-decked vessels the deck next below the shelter deck is to be regarded as the upper deck.

So far the question of freeboard determination has been considered from the viewpoint of its determination for some existing ship of which the characteristics are known. The most useful function of the work as presented here, however, is to permit a solution for the depth of a vessel under design. The *accurate* determination of freeboard should properly be attempted only from the complete tables referred to earlier, but from the information here presented, it is possible to readily determine the freeboard and therefore depth for a proposed design which has progressed sufficiently to have its length, draft, block coefficient and general arrangement selected. In general the coefficient of fineness" is sufficiently close to the block coefficient to accept the latter for entering the curves.

In considering a vessel under design, then, the general procedure for determining the freeboard of a full scantling vessel should be as follows:

1. Assume a *molded depth* which seems reasonable, enter the curves, and for this *depth* read off the freeboard for the proper coefficient of fineness.

2. Correct this freeboard for sheer and erections and add the corrected freeboard to the draft to determine a revised molded depth. Multiply it by 12 and the difference between this and the actual length gives the basis for determining the corrections for proportions.

3. Determine the correction for proportions and the original freeboard corrected for these three elements (sheer, erections and proportions) when added to the draft should give a molded depth in agreement with that originally as-

sumed. If it does not, repeat the solution, starting with a modified assumed depth. The first trial will rarely give agreement, but the second or third should suffice, or a curve for interpolation may be plotted as in Fig. 3.

The shelter deck steamers now form such a large proportional part of the tonnage afloat that they need to be built with as a special class, and the revised rules do so take cognizance of them. The freeboard of a shelter deck steamer must in no case be less than the freeboard which would be assigned to a complete awning deck steamer of the same dimensions. The shelter deck rules are framed for a vessel having a complete superstructure covering the full length of the vessel, the deck continuous and unbroken at the side, but having one or more openings along the middle line of deck, such openings not to have *permanent* means of closing in the shape of hatchways fitted with

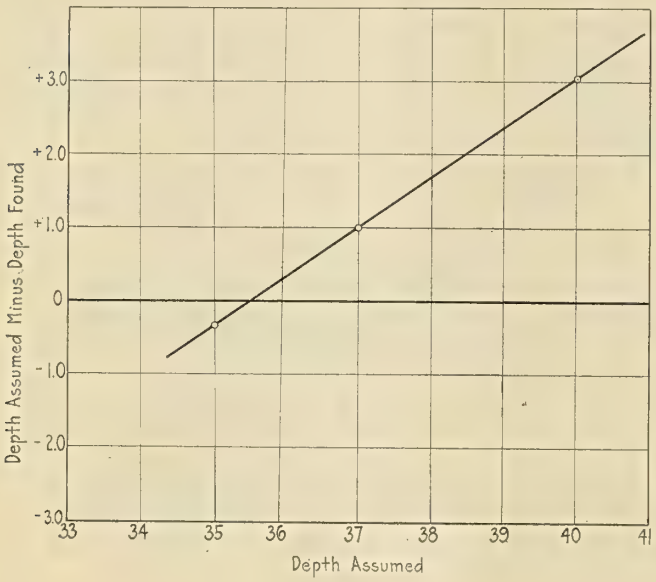


Fig. 3

coamings, cleats, etc. The deck below the shelter deck is called the upper deck and is the one to which freeboard is measured.

For shelter deck vessels the steps for determination of freeboard are the same as in full scantling vessels, considering them as full scantling vessels with very long erections and the freeboard is measured to the deck below the shelter deck (upper deck). The order of procedure is:

1. Assume a reasonable depth (molded) and read the freeboard from the curve for this abscissa on Plate II.

2. Correct this for sheer and use this corrected freeboard in estimating allowances for erections.

3. Correct for erections.

4. Use this newly corrected freeboard for determining the depth (molded) for proportions. Multiply it by 12 and

5. Correct for proportions.

6. Add this final freeboard to the draft and get a depth which should agree with that first assumed. If it does not, repeat the solution. Two or three trials should suffice.

In assigning freeboards to shelter-decked vessels, the following rules should be observed:

1. In making the sheer correction in accordance with paragraph on "sheer," the sheer is to be measured at the ends of the vessel, and the freeboard corrected for sheer is to be used in estimating the allowance for erections.

2. (*a*) If there is but one opening in the shelter deck the allowance for deck erections is to be determined from curve *A*, Plate IV, provided that the effective length of the shelter deck is not less than six-tenths of the length of the vessel.

(*b*) If there are two or more openings in the shelter deck the allowance for deck erections is to be determined from curve *B*, Plate IV, provided that the effective length of the shelter deck, excluding openings, is not less than six-tenths of the length of the vessel.

3. The effective length of the shelter deck is to be calculated in the following manner, provided the openings in the shelter deck do not exceed half the vessel's breadth at the middle of the length of the opening. The length is to be taken as if each opening were an open well. The value of each part is to be assessed in accordance with the different regulations affecting poops, bridge houses and forecastles, open or closed. The final allowance for erections will depend upon whether or not temporary but efficient means are provided for closing the openings in the shelter deck.

(*a*) If *efficient means* as specified below *are provided* for temporarily closing the openings in the shelter deck, the effective length of the shelter deck is to be reckoned as the length computed as prescribed above, plus half the difference between that length and the length of the vessel.

(*b*) If *efficient means* for temporarily closing the openinge *are not provided,* the effective length of the erections is to be computed by adding to the length computed as above one-fourth, instead of one-half, the difference between that length and the length of the vessel.

(*c*) If the openings in the shelter deck are wider than the half beam at that point, the addition to the assumed length of erections is to be modified in proportion to the relation which the actual opening holds to the specified breadth and to a complete well.

To illustrate the method of determining the depth for a new design, and also the application of the rules to the shelter deck type of vessel, the following example will be useful.

A complete shelter-deck vessel 490 feet long by 58 feet beam and 28 feet draft, with one tonnage opening in shelter deck. Block coefficient = .80. Assume for the first trial depth

$$\frac{L}{12}, \text{ or } \frac{490}{12} = 40 \text{ feet, approximately.}$$

	Feet
At 40 feet depth and .80 coefficient of fineness the freeboard for a full scantling vessel is 11 feet 8 inches (Plate II)	11.67
The sheer forward is 9 feet and aft 3 feet, so the mean sheer is $\frac{(9+3)}{2} \times 12 = 72$ inches. The standard or normal mean sheer from Plate IV is 60 inches, so that the excess sheer is $72 - 60 = 12$ inches, and the sheer correction is $12 \div 4 = 3$ inches $= .25$ foot	.25
This is to be subtracted, as the sheer is greater than the normal, then freeboard corrected for sheer is	11.42
Freeboard for awning deck (Plate III) (uncorrected)	8.41
Difference	3.01

The correction for erections is 90 percent of this (curve *A*, Plate IV) as the erections cover 95 percent of the vessel's length, $0.9 \times 3.01 = 2.71$. The freeboard corrected for sheer and erections then becomes $11.42 - 2.71 = 8.71$ feet; this, with a draft of 28 feet, gives a depth (molded) of $8.71 + 28 = 36.71$ feet.

A "standard" ship of this depth would have a length twelve times as great, or $36.71 \times 12 = 440$ feet (approximately), which is 50 feet shorter than the actual ship, so the freeboard must be increased to correct for proportions. From Table I this correction $\frac{1.7}{2}$ inch for every

10 feet excess of length, and the correction in feet is

$$\frac{1.7}{2} \times \frac{1}{12} \times \frac{50}{10} = .0708 \times \frac{50}{10} = .35 \text{ foot.}$$

Therefore the freeboard corrected for sheer, erections and proportions becomes 8.71 + .35 = 9.06 feet, and the depth (molded) is 9.06 + 28 = 37.06 feet.

This depth does not agree with that first assumed, so a second solution will be made, using the depth just found as a trial depth. Assume for the second solution a trial depth of 37 feet.

Freeboard of full scantling vessel	10.50
Less sheer correction	.25
	10.25
Freeboard for awning deck vessel	7.25
Difference	2.99
Correction for erections = .9 × 2.99	2.69
Freeboard corrected for sheer and erections	7.56
Draft	28.00
Depth of ship at 28 feet draft	35.56
Corresponding length of standard ship	427.00
Length of actual ship	490.00
Difference	63.00
Correction for proportions (.0708 × 63)	.43
Final corrected freeboard 7.56 + .43	7.99
Depth at 28 feet draft = 28 + 7.99	35.99

Repeating this process for a third trial depth of 35 feet, we obtain a resulting depth of 35.31 feet and freeboard of 7.31 feet.

From the above three solutions a plot like that of Fig. 3 may be made and the correct depth and freeboard determined from it for the case in hand. These are depth = 35.5 feet and freeboard (winter) = 7 feet 6 inches, or a summer freeboard of 7 feet.

TABLE III

Allowable Reduction from Winter Freeboard for Summer Freeboard. Double these reductions allowed for I. S. line and 2 inches more required for W. N. A. line if of 330 feet length or less.

Molded Depth.	Reduction, Inches.	Molded Depth.	Reduction, Inches.
16′ 6″ to 19′	2	34′ to 35′ 6″	6
19′ to 22′	2½	36′ to 37′ 6″	6½
22′ 6″ to 24′ 6″	3	38′ to 39′ 6″	7
25′ to 26′ 6″	3½	40′ to 41′ 6″	7½
27′ to 28′ 6″	4	42′ to 43′ 6″	8
29′ to 30′ 0″	4½	44′ to 45′ 6″	8½
30′ 6″ to 32′ 0″	5	46′ to 47′ 6″	9
32′ 6″ to 33′ 6″	5½	48′ to 50′	9½

Modern Submarines in War and Peace—IX

Submarines for the Recovery of Shellfish—Future Development of the Submarine and its Use in Warfare

BY SIMON LAKE

A submarine vessel of the Lake bottom-working type has been designed and is about to be built for the location of and the recovery of shellfish on a large scale. Shellfish abound on both the Atlantic and Pacific coasts in great quantities. They are about the most delicious and nutritious food known to man. The most common shellfish are the oyster, the round or hard-shell clam, the long-neck or soft-shell clam, the scallop, and on the Pacific coast, the abalone, which is valuable both for its mother-of-pearl shell, and its meat, which is a great delicacy, the most of which is sent to Japan either dried or canned.

My own sea-bottom investigations, combined with the sea-bottom investigations of the United States Fish Commission, have led me to the conclusion that edible shellfish abound in such great quantities along our coast that they can become an important rival to our meat-growing and packing industries, provided the proper apparatus is used for their recovery. I have, when "wheeling" along on the bottom, found beds of the round or hard-shell clam in such great quantities that there must have been thousands of bushels to the acre. This was in waters too deep to be recovered by the usual clammers' apparatus.

It is impossible to dredge for the soft-shell clam, as the shell is too delicate, and to pull them out of their bed would crush them. The abalone attaches itself to rocks, and it requires considerable force to break their hold, so there is no known means to recover them with surface ships.

The oyster industry is the only one that has thus far been developed by planting and cultivating methods, so that it is now a great industry, employing thousands of steam, internal-combustion and sail boats in their cultivation and collection for the market. The method employed by the largest growers is by the use of power boats, which drag "dredges," which are rakes with a meshed bag dragging on the bottom back of the tooth bar of the "dredge" to collect the oysters after they are "raked" or torn up from their beds. This is not a scientific method, for the reason that many of the oysters are killed by the heavy dredge being dragged over them. It is largely a "hit or miss" or "grab-in-the-dark" method, as it is impossible to "clean up" the ground in this manner. Some oyster grounds will produce from three to four thousand bushels of oysters to the acre. When "dredging" is started it is only necessary to drag the dredge a few feet before it is filled; then, as the oysters become thinner, the drag becomes longer. They drag in all directions across the grounds, but, as they cannot see the bottom, there are places they never hit, as the wind and currents prevent a systematic covering of the ground.

The design of submarine oyster-dredging vessel illustrated in Fig. 59 is such that the vessel goes down to the bottom direct, and the water is forced out of the center raking compartment so that the oysters may be seen by the operator in the control compartment. With only a few inches of water over them, headway is then given to the submarine and the oysters are automatically raked up, washed and delivered through pipes into the cargo-carrying chambers, as shown. Centrifugal pumps are constantly delivering water from the cargo compartments, which induces a flow of water through the pipes leading from the "rake pans" with sufficient velocity to carry up the oysters and deposit them into the cargo holds. In this manner the bottom may be seen, and by "tracking" back and forth over the bottom the ground may be "cleaned up" at one operation.

The design of vessel illustrated has a capacity of gather-

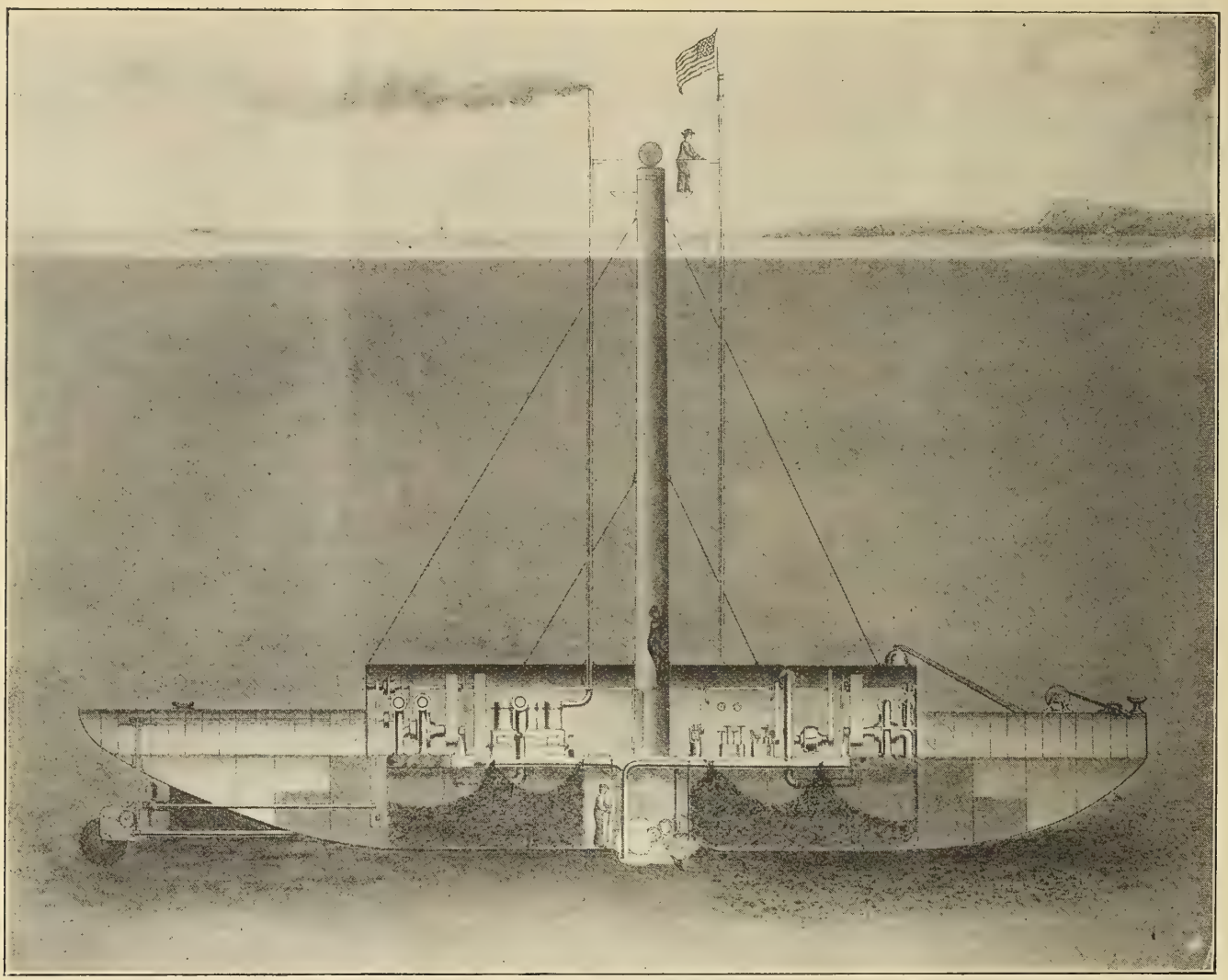


Fig. 59.—Submarine Oyster Gathering Vessel

By admitting water ballast into ballast tanks the vessel is allowed to sink to the bottom with sufficient weight to afford traction to the toothed driving wheels in the central operating compartment. This compartment is open at the bottom; water is prevented from entering it by the use of compressed air. As this compartment is well lighted the oysters may readily be seen lying on the bottom the full width and length of the compartment. When the boat is given headway the oysters are automatically transferred into the cargo holds as described on page 201

ing oysters from good ground at the rate of five thousand bushels per hour. The use of the submarine will make the recovery of oysters more nearly like the method of reaping a field of grain, where one "swathe" systematically joins on to another, and the whole field is "cleaned up" at one operation.

Submarines as Commerce Destroyers

Since beginning these articles ten months ago, nothing has as yet been invented or introduced to alter my opinion that the submarine is destined to be the premier weapon upon which maritime countries must depend for their defense. Much "ado" has been made about the "frightfulness" of the submarine. Nations that have used the submarine in an endeavor to prevent the transportation of munitions of war on the high seas—munitions of war or funds for the purchase of munitions of war which were intended to bring about the death of thousands of their own citizens—have, unfortunately, caused the death of non-combatants. They may or may not be justified in using the submarine in the manner in which it has been used, but the deaths of non-combatants have been trifling in comparison to the deaths of non-combatants that would have undoubtedly ensued had the submarine not existed as a factor in the war, and had the great fleets of surface ships been employed in the purpose for which they had been designed—in battling against one another, in the bombardment of coast cities, the chase and destruction of surface ships, etc.

Future submarines may be built that may avoid the apparent necessity of sinking without warning a hostile ship carrying contraband, but at the beginning of the war, and perhaps even to the present writing, *no submarine has had the ability to stop a high speed merchant ship except by sinking her during the few minutes* that she was in torpedo range. By means of the diagram shown herewith I hope to make this indisputable fact clear to every engineer or logical reasoner, irrespective of where his sympathies might lie, and I will describe the method that must be substantially pursued with most of the submarines now in commission.

In the diagram, Fig. 60, *A* is a merchant line ship that is pursuing her course in the direction of the arrow at a speed of, say, 20 knots; *B* is a submarine lying in wait for her enemies. If the submarine is lying in the light surface, or decks awash, condition, she might sight the approaching liner at a distance of ten miles. Her commander must immediately submerge to prevent discovery, otherwise the enemy ship would have time to sheer off and pass by out of range.

B then proceeds to maneuver for position so that *A* will

present a fair target of several hundred feet in length when *A* passes *B*. Now, *B* must not expose her presence until *A* gets within good torpedo range, which is not more than one-half a mile. For a swift-moving target, at a distance of one-half mile the periscope of a submarine is invisible to the naked eye of anyone on *A* when *B* is at rest, but as *B* can only fire her torpedoes in line with her own axis, she must secure and constantly maintain headway to direct her torpedoes towards the target *A*.

The navigator on *B* must also, by the use of his range-finders and direction indicators, be constantly employed in reading off distances and direction, and to also keep "tabs" on the speed of *A* to know how many degrees he must fire in advance of *A* to make a target. Now the

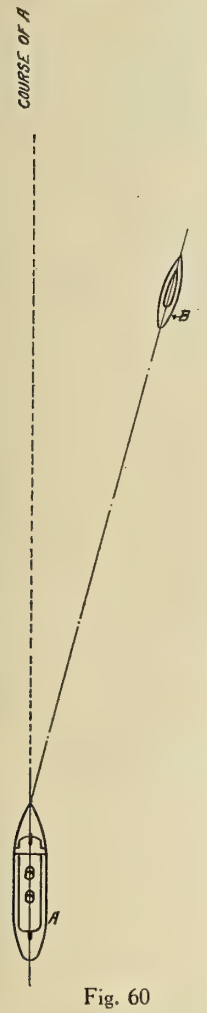


Fig. 60

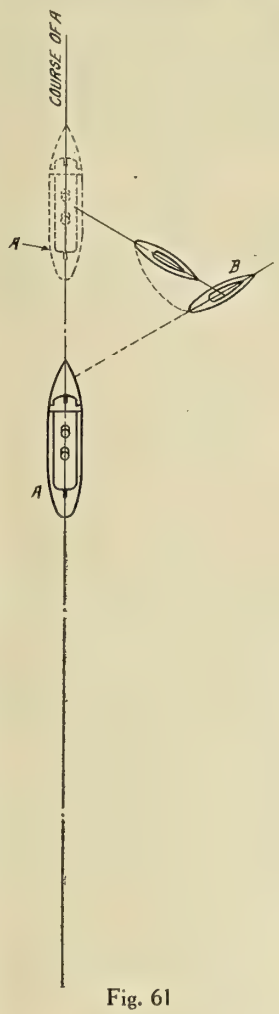


Fig. 61

speed of the torpedo is, say, 35 knots, and the speed of the ship *A* is 20 knots, the full length of the target, if of a ship 500 feet in length by 70 in breadth, is only presented when presenting a direct broadside to *B*. No submarine commander would be foolish enough to get in the direct course of *A*, as his target would be reduced to the thickness of the stem of the approaching vessel, as the water is deflected to either side of the stem of a moving ship, and the torpedo would probably be carried with the stream lines and not contact with the ship at all, or at best only effect a glancing blow. At the same time, the submarine commander would be placing his own vessel in jeopardy from being run down, so the maneuver is limited to the proceedings I have described.

When *A* has arrived in the position shown in full lines in Fig. 61 he must either cause *A* to stop before she reaches the position shown by the dotted lines, or his opportunity for capturing her is passed. Now it must be remembered that the speed of the ship is 20 knots and *B* is one-half mile from the line of the course of *A*. Therefore, *A* only has to run through one leg of a triangle which is also one-half mile, at her speed of 20 knots. This is at the rate of three minutes to the mile, or one and a half minutes to the half mile. Therefore, whatever is to be done must be done within one and one-half minutes. Now, when the periscope of *B* is first projected above the surface there is hardly one chance in a thousand that it would be even seen by the executive officer or lookouts on *A*.

The commander of *B* is now face to face with the following propositions, and he has only one and one-half



Fig. 62

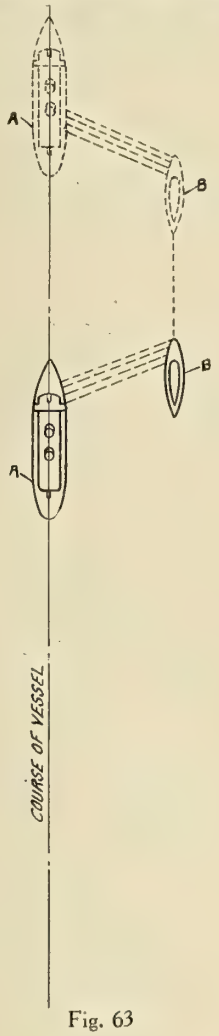


Fig. 63

minutes to decide it: Shall he let his country's enemy pass with perhaps sufficient contraband in the shape of munitions of war to slaughter hundreds or thousands of his own countrymen, or shall he quickly blow tanks, bring his own vessel up on the surface, blow whistles and set signals, in the endeavor to attract the attention of the executive officer of *A*, in the hope that the said executive will immediately give three bells and a jingle to stop—for, be it remembered, it takes considerable time to stop a large ship moving at 20 knots.

If the commander of the submarine adopts the latter course he puts himself and his own crew at the mercy of any marksmen who might be on *A*. Shall he do this? Or shall he stop the potential destructive energy that is being carried in the enemy's ship destined for the destruction of his own countrymen by using the only weapon

he has and fire a torpedo in the hope of stopping the enemy? I leave the answer to the patriotic sailors and soldiers of any nation.

I do not believe any submarine commander would, or has, wantonly sacrificed life, but what can he do? His difficulty lies in the limitations of the tools he employs. It is his bounden duty to his country to stop any ship carrying contraband. It was the recognition of this limitation of the present submarines that led me to reply to a telegram from the New York *Tribune* re the sinking of the *Lusitania* on May 11, 1915, in which I said: "I shall hope to see our government issue an official warning against Americans sailing on belligerent ships. I would also suggest that Americans sail only on American vessels which have been inspected by representatives of belligerents, certificates given that they do not contain contraband, and instructions cabled to their respective governments to give them a free passage."

The Congress of the United States recently voted, in substance, that it is beneath the "dignity" of a great nation to warn Americans to keep off from any belligerent vessel, whether carrying contraband or not, and that such vessels shall not be sunk and the lives of Americans thus imperiled. This is a very fine sentiment, and I hope it can be enforced from my American point of view, but from an engineering point of view that "dictum" interpreted means: No submarine shall be used to stop any belligerent vessels from carrying contraband on the high seas unless she first places herself at the mercy of the belligerent. Until all nations agree to this limitation of the submarine's function I shall hope to see Americans keep off belligerent vessels.

When this war is over and nations are again ready to "reason together," it is probable that new rules and regulations will be made governing the use of submarines, and it would seem logical that if a submarine got within torpedo range and could without question sink an enemy ship, and did not "for humanity's sake," that ship should no longer be used for the benefit of the enemy, but should be paroled in the custody of an officer from the submarine and proceed to a neutral port as a prize of war, not subject to recapture, and there interned until the final settlement of the differences. The ship would then be property which would be of value to both sides in the final settlement of accounts.

If the "dictum" is maintained that submarines shall not sink a belligerent merchant vessel without first giving warning and opportunity for escape of passengers and crew, that means that all submarines now in use by all nations are already obsolete, as far as their ability to stop armed merchantmen from carrying contraband of war is concerned. From the humanitarian point of view, it is unquestionably desirable that submarines have the ability to *capture* as well as *destroy*. Invention has already provided the means to accomplish this, but invention is much ahead of accomplishment.

Submarine of the Future

From a résumé of the foregoing, some predictions might be made as to the submarine of the future. *As such,* the submarine may be termed a perfected craft as far as general principles of construction and methods of control are concerned. Types are now in existence that can navigate successfully as surface boats and for hours at a time maintain within a few inches any desired depth between the surface and water bed. They may also remain at any desired depth while at rest, but not under way. They may also navigate over the water bed, and while on the bottom doors may be opened and the water kept from entering the vessel. Through these open doors divers may go out and conduct repairs to the submarine or work on or transfer cargo or stores from sunken wrecks or other submarines, mines may be planted or cables cut, communications may also be held between submarines while submerged, and so forth. But much yet remains to be accomplished regarding the submarine's auxiliaries, especially in relation to its propulsive equipment and machinery, both for surface and submerged work.

As previously stated, the internal combustion engine is ideal in principle for surface work, but at the present time it is complicated, noisy and unreliable. The storage battery and motor is in a more satisfactory stage for submerged work, in that the motor is almost noiseless and the battery will hold its energy without loss for considerable periods of time. There is room for improvement, however, in increasing the energy carried, both as regards weight and volume, if this can be done without a sacrifice of reliability. If future submarine commanders are to meet humanitarian requirements they must be in a position to demand "surrender" without placing themselves in a disadvantageous position. This calls for submarines of speed nearly approaching that of the surface vessel she wishes to capture. The writer had this in mind in the design of the Russian *Kaiman* and *Alligator* class of submarines, which were designed in 1905. Recently a notice appeared in the press that the *Alligator* had captured and brought into port a German armed vessel.

The United States submarine *Seal,* now called the *G* 1, as originally equipped, is the only vessel ever built in the United States that has had the capacity in principle to force the surrender of an armed surface vessel with speed superior to herself. Reference to the diagrams and Figs. 62 and 63 will, I hope, make clear the great advantage of vessels of the *Seal* type to capture rather than to destroy. The *Seal,* as originally built, was fitted with four torpedo tubes that could be trained to fire torpedoes to either broadside, and in her acceptance trials she successfully fired torpedoes in this manner, both submerged and on the surface. A photograph of the *Seal* firing one of her torpedoes from a broadside training tube is shown on page 560 of the December issue of this magazine.

Referring now to Fig. 62, the same tactics are pursued as described in relation to Fig. 60, except that the submarine, instead of heading *towards* the approaching enemy, heads *away* from her and remains at rest entirely submerged until the enemy reaches the same relative position as described in relation to Fig. 61. She then trains her broadside tubes on the enemy (see Fig. 63), blows out sufficient of her water ballast to enable her to start her engines under full power, breaks out her signals to surrender and starts at full speed ahead, *parallel* to the enemy ship, with four torpedoes constantly aimed at the vitals of the enemy. In Western parlance, she has "got the drop on the other fellow."

In this condition, if the submarine has a surface speed equal to the enemy's speed, she can keep a parallel course and maintain "the drop" as long as the commander of the submarine elects, or she may thus be escorted to and forced to enter a neutral port and there interned, or if the exigencies of militarism require it, she may be held until the passengers and crew have escaped and then be sunk.

Assume that the surface vessel had a speed of 20 knots, as before, and the submarine a speed of only 15 knots, which is now within the possibilities in a submarine of about 750 tons displacement, which would be of sufficient size to carry satisfactory broadside firing torpedo tubes. In this case the surface vessel would only have an advan-

tage of five knots in speed, which is at the rate of twelve minutes to the mile. Therefore, starting from the same relative positions, in which the submarine is one-quarter of a mile ahead at the start, it would take the 20-knot ship nine minutes to get one-half mile ahead, out of sure shot range, instead of only one and one-half minutes, as in the previous case. This would be ample time to enable the executive officer of the enemy ship to come to his senses and decide as to whether he preferred to surrender or be sunk. With four Whitehead torpedoes aimed at his ship, all of which could be instantly fired on the first sign of resistance, I think there would be only one thing for any sensible commander to do, and that is to surrender without demand of any kind whatsoever.

Certain other improvements might be mentioned and other tactics described, but owing to the present somewhat strained relations existing between the United States and other countries, I do not feel that any further disclosures should be made at the present time. For the same reason I feel compelled to refrain from describing what may be done with surface ships to make them unsinkable from the explosion of a Whitehead torpedo.

Appeal for Research Laboratory

In conclusion, I wish to make an appeal for the establishment of such a research bureau and laboratory as has been recommended by the civilian advisory board of national defense which has been created by Secretary Daniels.

The inventive genius of the country has been greatly handicapped by lack of capital and direction. It is a notorious and not very creditable fact that many of the country's inventors have been driven abroad for that recognition which should have been granted them in their own country. Invention and design, while similar in some respects, are quite distinctive in other respects. Invention requires original thought and freedom from set, formulated rules that have been designed to meet old and existing conditions, while design requires a knowledge of and studious analysis of all old things and its application to new. History shows that most of the great inventions that have made Americans prominent in the line of original thought have been made by men outside of the professions which benefited by them—Fulton, Ericcson, Hotchkiss, Sir Hiram Maxim, the Wrights and many others who have made important contributions to the art of defense, were men originally engaged outside the profession which ultimately benefited by their original conception.

To carry an invention to a successful conclusion requires: first, the original conception; second, capital; third, that which only capital can provide, analysis and the working up of the original conception into a practical machine or process. Undoubtedly, we have among our people many original conceptions that may prove of benefit to the nation for purposes of defense or offense. To take advantage of these, Congress should provide the capital. Army and navy officers should pass upon their utility, and could greatly assist in the development of such ideas as might be considered of importance by the Advisory Board. A thorough investigation should be conducted as to their originality and utility, to show that the ideas are worthy of development.

In carrying out this idea, it is obvious that the men comprising the Advisory Board are mostly men of large affairs and therefore they cannot be expected to give up their valuable time to detail work of making researches and investigations or to the supervision of design and experiments. A large force will, therefore, be needed to conduct such work and the amount of $1,500,000 (£308,000) now asked for will not go far if many lines of research and development are to be undertaken. Many private corporations have expended greater sums than this in the development of devices applicable to defensive purposes.

Provision should also be made to protect and properly compensate inventors for their ideas in proportion to the value of their inventions. It is only by treating them fairly that their confidence and co-operation may be secured.

It is to be hoped that private interests will not oppose the granting of money which the Advisory Board requests. It sometimes happens that private capitalists will do everything within the law, and sometimes things without the law, to protect devices of their own manufacture, thus to maintain a monopoly on their own goods. They have been known to do this, even where the safety of the nation is concerned.

(*The End.*)

Dry Steam in Scotch Boilers—Remarkable Performance of the Steamship Bristol

The steamship *Bristol,* built by the New York Shipbuilding Company, Camden, N. J., for the Coastwise Transportation Company, Boston, Mass., has just completed her maiden voyage from Norfolk, Va., to Boston, and as this vessel is fitted with Scotch boilers equipped with the first merchant ship installation of an invention for drying and superheating the steam *wholly within the boilers,* the very satisfactory performance of this vessel is of exceptional interest. The apparatus here used is the Lovekin internal superheater and drier, which gave throughout the trip nearly absolutely dry steam. As results are what count and as these results are quite phenomenal, we append selected data from the official report of the trial bearing on the steam quality and general features most important for obtaining a fair comprehension of the conditions.

One remarkable showing was that a drop of only 6 pounds was sustained from the boiler pressure to the admission line of the high-pressure cards, and of course the maintenance of steam by the engine containing only .554 percent moisture is something heretofore unheard of in ordinary Scotch boiler performance.

The dryness of the steam was ascertained by a Carpenter calorimeter used with great care, and the average quality of 99.44 percent dryness is remarkable when it is considered that the temperature of the gases at the inlet to the drier was never more than 500 degrees F. This particular installation was designed for dry steam only and not for superheat.

Preliminary Report S. S. Bristol for 80½-Knot Run on Maiden Voyage Between Norfolk, Va., and Boston, Mass.

Size of engine cylinders	23¼, 38½ and 67 inches diameter by 45 inches stroke.
Number of boilers	2
Type	Scotch
Total steaming time	53 hours 59 minutes
Speed, knots	10.78
Average revolutions per minute	75
Average indicated horsepower	1,795
Draft, leaving Norfolk, mean	24 feet 9 inches
Displacement, leaving Norfolk	9,630 tons
Vacuum, inches	27

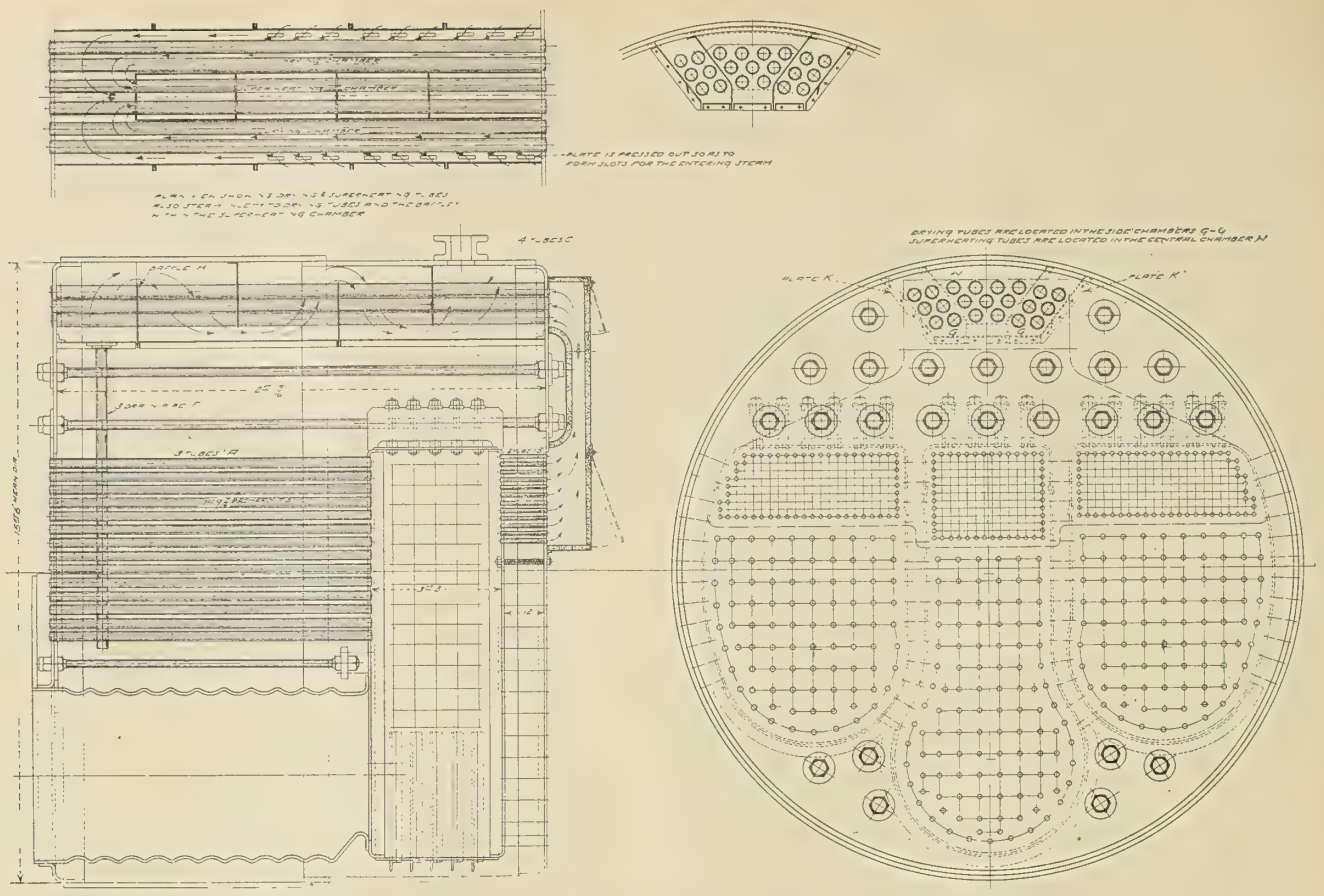


Fig. 1.—Scotch Boiler for S. S. *Bristol*, Fitted with Lovekin Internal Superheater and Dryer

Air pressure at fan, inches	1.3
Port boiler pressure, gage	161
Starboard boiler pressure, gage	163
Calorimeter temperature, port	297
Calorimeter temperature, starboard	300
Temperature of gases, inlet to steam heater	419
Temperature of gases, base of smokestack	496
Quality of steam, average both boilers	0.9944

The boilers after steaming 57 hours and standing with banked fires for 22 hours, upon opening of the superheaters and combustion spaces showed almost no signs of soot and no tube leakage, especially the superheater tubes. The boilers were equipped with Diamond soot blowers, and also Eckliff water circulators.

In the Lovekin steam drier and superheater fitted to the boilers of the *Bristol*, as shown in Fig. 1, steam enters through various lattice openings in the sides of the outer casings and passes over the drying tubes, where the greater part of the moisture is taken out of the steam. Any water remaining settles in the chambers *G G* and is drained to the lower part of the boiler by pipes *F*. The steam travels over the drying tubes towards the front of the boiler, where it enters the superheating chamber over baffle *H*. The steam is then compelled to pass in counter currents over the superheating tubes several times, due to the arrangement of the baffles as shown, and finally leaves the boiler at a point where gases of the highest temperature are entering.

It will be noticed that with this arrangement there can be no possibility of any moisture which may be carried along with the steam current affecting the final superheating of the steam, as the moisture is either all absorbed by the drying tubes before it enters the final superheating chamber, or is collected and drained off. All plates are

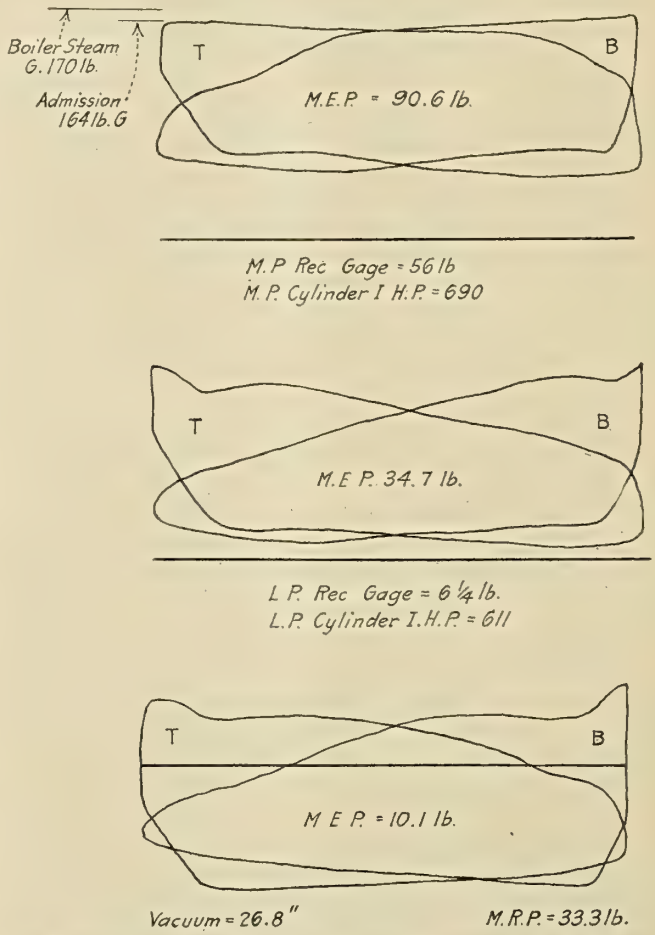


Fig. 2.—Indicator Cards Taken on Maiden Voyage of S. S. *Bristol*

made removable in order to give access to the boiler for examination.

The location of the slots for the entering steam is in a most favorable position for avoiding any water being thrown into same, which may be caused by rolling of the ship, or otherwise.

Heating Surface

Heat surface, tubes *A*	1,988 square feet
Heating surface, tubes *B*	178 square feet
Heating surface, furnaces	307 square feet
Heating surface, combustion chambers	312 square feet
Heating surface, back tube plates	84 square feet
Total heating surface *	2,869 square feet
Superheating surface, tubes *C*	266 square feet
Total heating and superheating surface	3,135 square feet
Volume, combustion chambers	325 cubic feet
Volume, furnaces	292 cubic feet
Total volume, combustion space	617 cubic feet
Calorimeter, tubes *A*	12.6 square feet
Calorimeter, tubes *B*	3 square feet
Calorimeter, tubes *C*	1.4 square feet

* Note: The heating surfaces are figured for oil fuel.

Efficient Steering

BY CHARLES R. PRATT *

The quicker a rudder moves the fewer degrees it has to swing and less retardation is given to the speed of the boat.

While this has been well known ever since the days of the Roman galleys, there has never yet been built a steering gear adapted to the actual work required in swinging a rudder.

Why keep hand wheels or power units constantly geared to put the rudder to "hard over" when it is seldom put there during an entire voyage? It only requires one-tenth the torque to put the rudder to a maximum cruising angle, and one-twentieth to an ordinary cruising angle; therefore, while it remains geared for "hard over," it only moves at one-tenth or one-twentieth of the speed that the power unit or hand wheels could move it during the whole voyage.

There is but one way to obtain "efficient steering" and that is by varying the leverage (gear) between the rudder and the power unit or hand wheels automatically by and in proportion to the sea pressure on the rudder. The writer has patented a device, shown in the illustrations,

* Consulting Engineer, 55 Liberty street, New York.

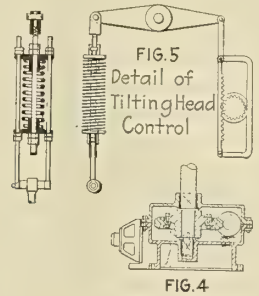


FIG.4
Detail of Pilot Motor Gearing

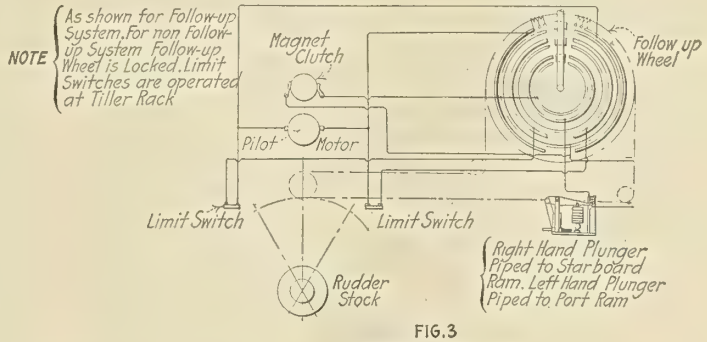


FIG.3
Wiring Diagram

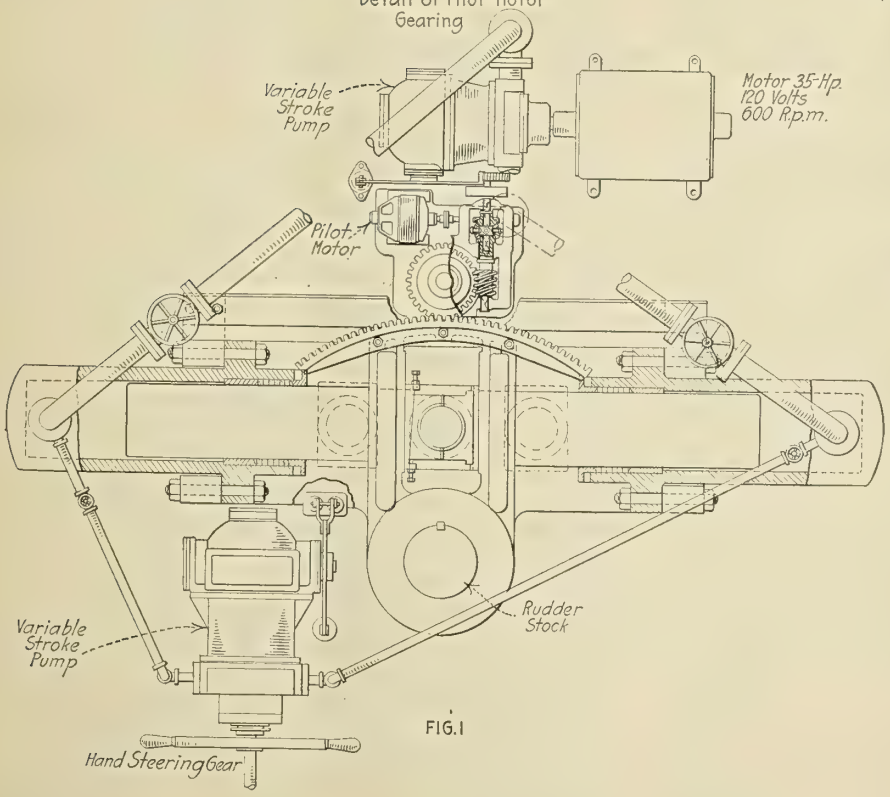


FIG.1

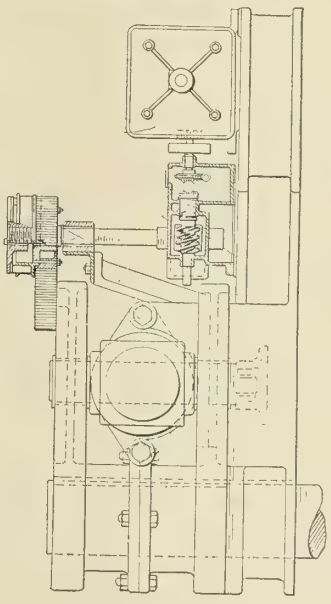


FIG.2

Details of Improved Steering Gear

which provides a very simple and efficient way to accomplish the required result. As hydraulic rams operated by a variable stroke pump have an average efficiency of 75 percent as against 25 percent for nuts and screws, or low pitch worm gears, this device, when using a 10 to 1 variation of leverage gives thirty times the rudder speed of the usual steering gear when using the same size power units, or, with the same number of men at the hand steering wheels, thereby making hand steering as efficient as power steering, and without having to slow the boat down to one-fourth speed when hand steering has to be used.

Hand Steering

Considering this device first for hand steering, we find by reference to Fig. 1 the tiller moved by hydraulic rams operated by a variable stroke pump, one pump driven by an electric motor for power steering and the other pump shaft turned by hand-steering wheels, closing the valves to one pump and opening them to the other pump shifts from power to hand steering. The stroke of the hand-steering pump is controlled by a lever which at one end has a spring keeping the pump at full stroke, while the rudder swings towards amidships and up to an ordinary cruising angle, giving the rudder thirty times the speed obtained by nut and screw gear, with the same number of men at the wheels.

When the action of the sea, the motion of the boat or swinging the rudder to a greater angle increases the sea pressure on the rudder, the fluid (oil) pressure on the ram (starboard or port) resisting same, operates one of the two small plungers on the other end of the pump control lever, overbalances the spring and shortens the stroke of the pump, thereby automatically increasing the leverage between the hand-steering wheels and the rudder in exact proportion to the increase of sea pressure on the rudder. By this device it requires no more manual effort to put the rudder to "hard over" than it takes to put it to an ordinary cruising angle. A quick adjustment of the spring pressure alters the automatic change of leverage to suit the number of men available for steering, whereby one man can do the work of twenty men at one-twentieth of the rudder speed.

Power Steering

In power steering instant precision of control between the steering wheel and rudder is quite as important as high rudder speed. With a telemotor the rudder lags several degrees behind the steering wheel in starting and runs several degrees beyond it in stopping, all of which has to be anticipated and controlled by a very expert helmsman. The usual electric steering gear has the unavoidable complication of magnet switches and resistance required to start and stop electric motors of over 20 horsepower, and the delayed action, due to the inertia of starting and stopping a heavy high-speed armature, thereby giving little, if any, better control than a telemotor.

The device illustrated uses a pilot motor operating on an entirely new principle which may be described as the combination of a member to be operated (the rudder), actuating means therefor (the pump), a pilot motor controlling said means, means dependent on the *torque* of the pilot motor for governing the actuating means, and means for governing the *torque* of the pilot motor. Heretofore pilot motors have controlled power units either by a step by step action or by varying their speed by field resistance, neither way giving results of precision. Reference to Fig. 1 shows the pilot motor geared to the tiller segment through a set of differential gears, the planetary pinions of which are geared to the lever controlling the stroke of the pump.

This pump shaft is driven continuously in one direction by the power unit (electric motor) and operates the rudder by reversing its stroke, thereby reversing the flow of fluid pumped to one ram and discharged by the other ram back to the pump. Its stroke control lever shown in Fig. 5 has a centering spring which keeps the pump at zero stroke when the rudder is stationary and opposes the torque of the pilot to increase the stroke in either direction (starboard or port) by action of a rack and pinion on the other end of the control lever. Incidentally, the full torque of this pilot motor is transmitted to the rudder, assisting the rams by that small amount, one horsepower.

As a rudder should always move at maximum possible speed, this pilot motor is started instantly at full speed in either direction with no armature resistance. This overcomes the centering spring, starts the pump off zero stroke and starts the rudder in about one-tenth of one second after closing its circuit with the steering wheel, getting the pump to full stroke and the rudder to full speed in the least time possible. In stopping the rudder, a magnet clutch breaks the connection between the pilot motor gears and the rack and pinion on the pump control lever, allowing the centering spring to snap the pump back to zero stroke and stop the rudder instantly.

The precision of this control as applied to a variable stroke pump operating an elevator in the testing tower of the Otis Elevator Company indicates a rudder control of one-twentieth of one degree with the steering wheel, as against several degrees by any other type of steering gear.

Fig. 3 shows the electric control, which can be either follow-up or non-follow-up, and also shows a rheostat operated by two spring-balanced plungers piped to each rudder ram, whereby the sea pressure on the rudder varies the torque of the pilot motor by its armature resistance and thereby the stroke of the pump and the leverage between the power unit and the rudder the same as in hand steering, whereby a one horsepower motor can handle the rudder as well as a 30 horsepower motor operating nuts and screws, or the same size motor can move the rudder at ordinary cruising angles at thirty times the usual speed, or any intermediate condition that may be required can be obtained.

The rudder is held stationary against leakage of rams and pump by a friction clutch shown in Fig. 2 and by the locking action of the worm gear on the segment pinion shaft. This avoids the continual action of the pump at short stroke to hold the rudder stationary, but it slips against excessive sea pressure when the relief valves open and allow the rudder to swing towards amidships. With a follow-up control the rudder is automatically returned instantly to its exact original position.

The novelty of this device and the fact that these drawings show every working part suggests a relatively high cost and complication, whereas a careful investigation will show a reduction in cost in comparison with other steering gears, with simplicity in construction and reliability in action. Its reliability has been proved beyond all question by the "Hele-Shaw-Martineau steering gear," which has every element of this device except the *automatic* change of leverage by the sea pressure on the rudder and that it controls the pump by telemotor instead of by this electric pilot motor. Up to January, 1914, there were 35 boats of from 600 to 28,000 tons equipped with this steering gear. Any boat now using a Hele-Shaw-Martineau steering gear could have every element of this control applied to it quickly and at small expense.

The Hele-Shaw pumps and the pumps shown on this drawing are piston or plunger pumps, pumping oil at 1,000 pounds pressure per square inch, without valves or packing, and with an efficiency of 90 percent.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

A Handy Kink

Readers of MARINE ENGINEERING may be interested to learn that a large percentage of the burned-out Mazda or Tungsten lamps may be easily repaired. It is a fact that if the broken ends of the filament can be brought into contact with the curent on the lamp, the ends will fuse together and become permanently welded. If the filament is broken in only one place the ends may be again brought into contact by screwing the lamp into a portable socket and, holding it in various positions, gently tapping the lamp with your finger or gently shaking it to set up a little vibration in the filament. If the ends of the broken filament can be made to touch, the current flashes across and the job is done and the lamp is practically as good as ever. A little practice enables one to become quite adept in applying this kink to practical economy.

B. SAWYER,
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Norfolk, Va.

How Feed Water Should be Discharged Into a Scotch Boiler

There are several fundamental principles which govern the location of the feed outlet in a Scotch boiler, and the designer must bear in mind the conditions under which the boiler is to be used.

1. As a general rule, feed-water heaters are installed in all first-class plants, either stationary or marine, and the feed water enters the boiler at about 200 degrees F., and the customary practice is to discharge the water above the tubes just below the water level, not from the open end of the pipe, but through two or more branches led over the tubes with the ends closed and the sides perforated with small holes, the combined area to be 1½ times the area of the feed pipe; in this manner the water will be uniformly sprayed over the surface.

When water enters the boiler at 200 degrees F. in the manner described it has its best advantage and is rapidly evaporated into steam. Due to this high temperature, it has an advantage of 2 pounds per horsepower per hour.

If this discharge were led to the bottom of the boiler, where the water is fairly cold (and it is seldom any other way unless a system of perfect circulation is provided) the effect of the heater would be entirely destroyed.

To bear me out in this I will cite a recent instance of a small tug boat with a compound engine non-condensing one Scotch boiler with 1,200 square feet heating surface and 40 square feet of grate surface and no heater. At the suggestion of the owner, a good feed-water heater was installed. After several weeks there was no noticeable difference in the consumption of fuel, and it was then that the writer discovered that the internal feed pipe discharged its water near the bottom of the boiler. This was immediately changed and placed above the tubes in the manner previously described, and better results were noticeable from the start. The exact extent of economy was not recorded, but was about 140 pounds of coal per hour, enough to prove that the change was very desirable.

2. If there is no feed-water heater installed and the feed is made up with cold water from the fresh-water tanks, it is the writer's opinion that the proper place for the discharge is near the bottom of the boiler, using a tee fitting on the internal pipe with an open end branch in each direction. This, of course, should not be so close to the bottom as to stir up sediment.

When water enters the boiler thoroughly cold it is advantageous to have the discharge as far away from the water level as possible. Cold water entered at the water level prevents proper evaporation.

3. The United States Steamboat Inspection rules require all boilers to have two feed connections, main and auxiliary; sometimes the auxiliary feed is connected only with the injectors and is seldom used except for supplying the boilers sufficiently to keep auxiliary machinery running when the main units are shut down; the discharge then should be placed over the furnaces and sprayed over the surface, as in case No. 1.

When the auxiliary feed is supplied with an independent feed pump, using cold water, the same case applies, and the discharge should be placed over the furnaces, this being the most effective part of the boiler when the fires are banked.

4. In some plants the auxiliary feed pump is used in case of an emergency, and is connected to the main feed line and heater, and should discharge over the tubes just below the water level, as in case No. 1.

5. The feed valves can be located in any convenient place on the boiler; shell, backhead or front head, if sufficient space can be found, but in no case should the discharge terminate above the water level in the steam space, for the reason that it produces excessive priming and also excessive air hammer in the feed line. Great quantities of air pass into the boiler with the water at all times, which produces a certain amount of hammer in the line. To overcome this an air chamber of ample capacity should be placed on the discharge side of the feed pump or in some convenient place in the feed line.

New York.

R. R. ROANE,
Mechanical Engineer.

Analyzing a Marine Steam Plant

To the practical marine engineer it often remains a mystery why one plant is more economical than another, and why one engine differs from another, although built from the same drawings. Many boats are known to have something wrong with them, yet there seems no way of getting at the trouble without turning the ship over to experts, which is usually expensive, inasmuch as it either lays up the ship or puts the company to the expense of carrying several experts for a trip or two, besides their remuneration. To that growing class of marine engineers who are willing to think, it is not a difficult task thoroughly to check up the possibilities of their plants; nor does one have to be highly educated to do it. Before taking up the steps of an analysis, it is well to review briefly the governing features of design.

A small, medium speed boat operating on short trips need not go to the expense of putting in a highly economical plant, and compound engines will often answer.

Higher speed boats, or those intended for longer trips, are constructed with more economical plants. The higher the steam pressure, the greater the economy and the number of expansions. The higher the steam pressure, the more expensive is the engine and the greater the amount of coal burned per square foot of grate surface, although this is compensated for by greater efficiency.

The number of expansions of steam is the volume of steam at cutoff in the high-pressure cylinder, divided into the total volume of steam in the low-pressure cylinder, just before exhaust. These expansions are divided into two, three or four stages, known as compound, triple, etc.

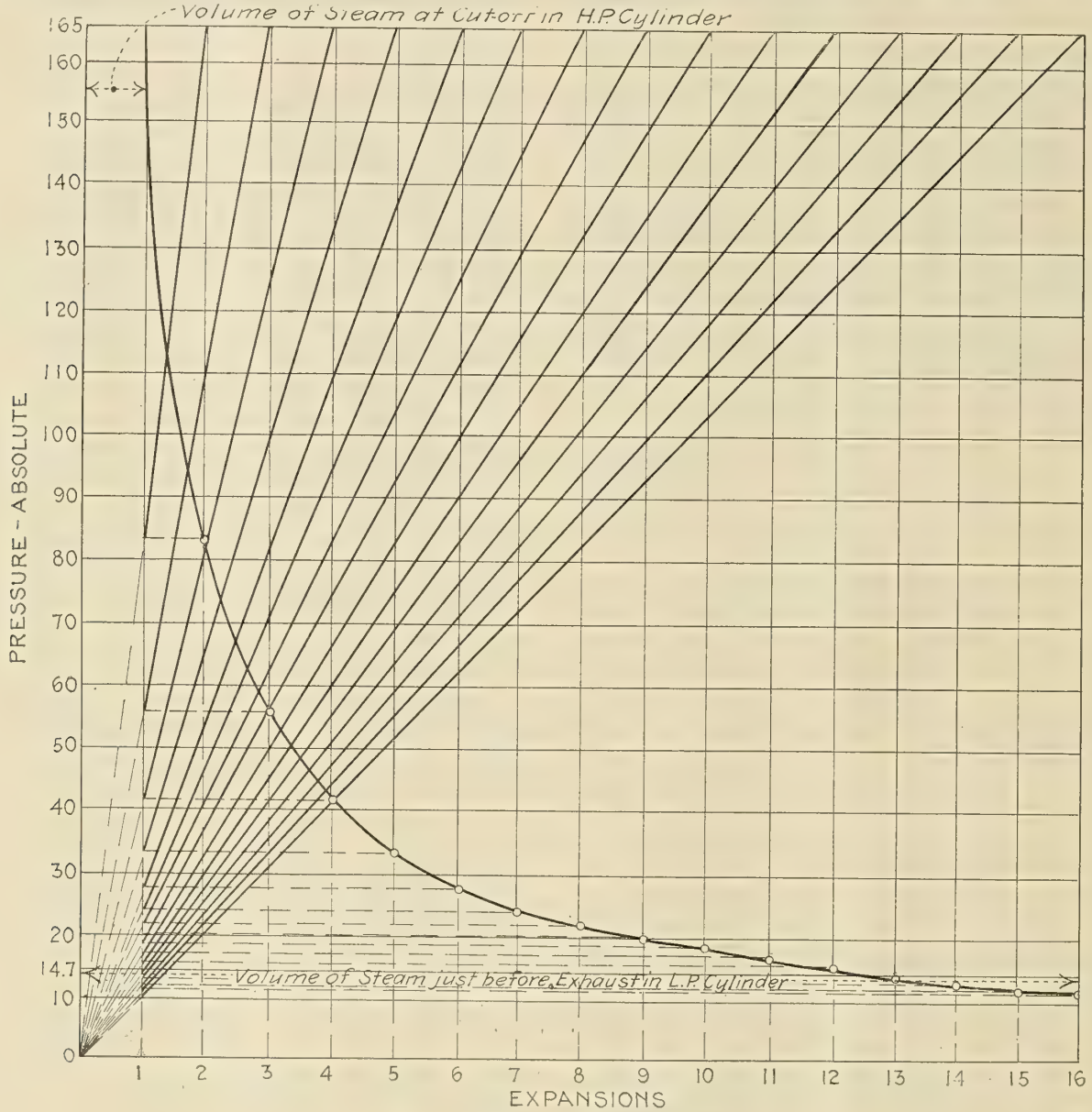


Fig. 1.—Theoretical Expansion Curve

The clearest way of showing the possibilities of any marine plant is by means of the combined card, which shows the possibilities of the entire plant, from boilers to condenser. Suppose that we have a regular triple expansion plant of average design. Such a plant will have about sixteen expansions, when the high-pressure cylinder is cutting off at three-quarters of the stroke. Assume that this plant carries 150 pounds of steam, say about 165 pounds absolute pressure, reckoned from vacuum. Tables of expansion of steam, which can be found in almost any engineers' pocket book, tell us that for sixteen expansions the mean pressure will be 23.5 percent of the absolute boiler pressure and cutoff at 6.2 percent; that is to say, that if the boiler pressure were put in the low-pressure cylinder and the cutoff placed at 6.2 percent (which, of course, is impractical), the low-pressure cylinder would generate the full power of the engine, with the same number of expansions. This gives an easy method of figuring what horsepower an engine ought to develop, but it would not be economical in practice.

The reason that more than one cylinder is used is to enable the higher pressure cylinders to stay hot, without being cooled down by the low-pressure steam. The same table tells us that at sixteen expansions the terminal pressure would be 6 percent of the absolute boiler pressure. This would be six times 165 divided by 100, or 9.9 pounds per square inch. This is equivalent to a vacuum of about 10 inches of mercury. In practice, the vacuum is always lower than the theoretical line.

Let us take now a piece of drawing paper and near the bottom draw a zero line. At right angles to this draw another zero line. Divide the vertical line into divisions representing 165 pounds absolute pressure. Divide the horizontal line into 16 expansions. Draw in the one vol-

ume of steam and the 9.9 pounds terminal pressure. Then by means of the dotted lines, as shown, draw in the theoretical expansion curve, known as the hyperbola. It is drawn through the corners of the squares, as shown in Fig. 1.

We now have as a starting point a triple expansion plant which expands the steam sixteen times, beginning with 165 pounds absolute pressure, and with ten inches of mercury in the condenser. We have the theoretical expansion line and the theoretical mean effective pressure for the whole engine, referred to the low-pressure cylinder, thus showing the theoretical horsepower for any engine. We will begin at the boiler and go through an entire average plant, noting how closely it complies with the theoretical results, and why it falls below them.

Fuel

A British thermal unit is the amount of heat necessary to raise the temperature of 1 pound of water 1 degree F., and 2,545 B. T. U. is one thermal horsepower—that is to say, if 1 pound fell 33,000 feet in a minute, or was projected out of a cannon at a velocity of 33,000 feet per minute and struck a target, 2,545 B. T. U. would be given off in heat, etc. This is what causes heat and sparks on impact, and is the reason some blacksmiths can hammer a piece of iron until it is hot.

Good coal has a calorific capacity of 12,500 B. T. U. per pound, poor coal a calorific capacity of 8,500 B. T. U. per pound. As a rule, it is poor economy to buy cheap coal, because it has 25 to 35 percent less heat and costs only 5 percent to 10 percent less. Pure anthracite contains about 14,000 B. T. U. per pound, which accounts for its excellence as a steam coal. Fuel oil averages 19,000 B. T. U. per pound. It occupies about the same volume, ton for ton, as coal. The light oils have greater calorific value per pound, but less per barrel, and they are usually paid for by the barrel. With the heavy oils the converse is true.

The average triple expansion marine engine working on sixteen expansions will use a little less than two pounds of good coal per horsepower hour, or a little more than two pounds of poor coal. The same engine will use, roughly, a pound and a quarter of fuel oil per horsepower hour. For the remainder of this article, coal will be considered exclusively, for the analysis of a marine plant.

The first possible source of loss is in firing. When the fires are covered with a fresh layer of coal, a small portion of the live hot coals should be left uncovered, so that the heat can ignite the immense amount of tar and gas that is distilled from the fresh coal, and otherwise appears as green and black smoke in the stacks. As soon as the furnace door is closed after firing, the door shutters should be opened to furnish air to burn the vapors and tars referred to above. When the coal becomes thoroughly incandescent, the shutters should be closed, since there is no longer an excess of combustible matter above the fire bed.

Another great source of loss is excess air. The amounts of air admitted to the furnaces should be regulated so that the stacks do not smoke, but they should almost smoke. It is easy to run two or three times as much air as is necessary through the furnaces, and every 100 percent means an approximate loss of about 8 percent in fuel, since it costs just as much to heat air as to heat water, pound for pound.

There is only one way to know how good combustion is. That is to use a simple device known as an Ellis tube and test a sample of the smokestack gases for carbon dioxide. Any engineer can use the tube and any chemical house sells and explains how to use it. Perfect combustion produces about 16 percent carbon dioxide in the stack gases. If the instrument shows 14 percent carbon dioxide, combustion is very good. If the percentage drops to 6 percent, there is either too much air going through or not enough. Another chemical is put in the tube and another sample tested for carbon monoxide (partially burned carbon). If anything over 3 percent of this shows, it is fairly certain that there is not enough air under the grate bars. If the quantity of monoxide is only a trace, it is pretty certain that there is too much air, which is the more usual fault.

The efficiency of the combustion cannot be judged very accurately by the smoking of the stacks, because when fresh coal is laid on no amount of air will burn the smoke because there is nothing to ignite it. On the other hand, the stack may not be smoking at all, yet that hotbed of fuel will be pouring out quantities of carbon monoxide, which is invisible and all of which represents a fifty percent waste while it lasts. There are now on the market recording devices which automatically take and test samples of stack gases and trace a curve, which on a large ship is a very valuable index of how firing is being conducted, and shows at just what times of day the bad firing was done. These may be procured from several large chemical firms and cost from $200 to $300 (£41 to £62).

A good boiler, working under favorable conditions, will absorb 85 percent of the heat generated by the fuel, 75 percent is more usual, and 50 percent is not unknown, particularly when the boiler is in bad condition from scale or salt or soot.

Suppose that the feed water enters the boilers at a temperature of 120 degrees F., which would be an average condition, and must be heated to 165 pounds pressure. By reference to the tables of saturated steam, we find that the temperature of saturated steam at 165 pounds absolute pressure is 365.7 degrees F. In other words, water boils at 365.7 degrees F. at 165 pounds absolute pressure. To be heated from 120 degrees to 365.7 degrees would require 366 minus 120, or 146 B. T. U. for one pound of water.

Next, we find by the same steam tables that it takes 855 B. T. U. to evaporate the water into steam at 165 pounds absolute pressure. This gives a total of 146 plus 855, or 1,001 B. T. U., as the heat necessary to evaporate a pound of water, first heating it from 120 to 366 degrees F., then evaporating it into steam at 165 pounds absolute pressure. We will call it 1,000 B. T. U., as a more convenient number.

Assume that a pretty good coal, having a calorific value of 12,500 B. T. U., is used; then 12,500 B. T. U. divided by 1,000 gives 12.5 pounds as the amount of water each pound of coal should evaporate theoretically. If the boiler is in pretty good condition and receives 80 percent of the heat, the coal may be expected actually to evaporate 80 times 12.5 divided by 100, or 10 pounds of water, which accords with usual practice.

In order that different boilers may be compared, since they are not all operating at 165 pounds pressure, nor does the same boiler operate at the same pressure in different tests, it is customary to reduce the actual evaporation to a common standard, known as the equivalent evaporation from and at 212 degrees F. This is done by first dividing the actual heat received by the boilers by 965.7 B. T. U., which is the amount of heat necessary to evaporate into steam 1 pound of water at 212 degrees F. The B. T. U. actually received by the boiler per pound of fuel burned is obtained from a test in which all temperatures are obtained, also the quantities of feed water and the time.

The "boiler horsepower" is the evaporation of 30 pounds of water per hour from 100 degrees F. to steam at 70 pounds pressure. The heat required is 33,305 B. T. U., and is almost exactly thirteen times a theoretical horsepower of 2,545 B. T. U. The basis for this rating is that the ordinary simple slide valve engine uses about 30 pounds of water per horsepower hour. It might be mentioned here that a compound engine uses 13 to 16 pounds of water, a triple expansion engine 10 to 12 pounds, a quadruple expansion engine 8 to 11 pounds, and steam turbines all the way from 12 to 17 pounds per horsepower hour. Greater economy could be realized in marine turbine plants if much higher speeds could be provided for in the design.

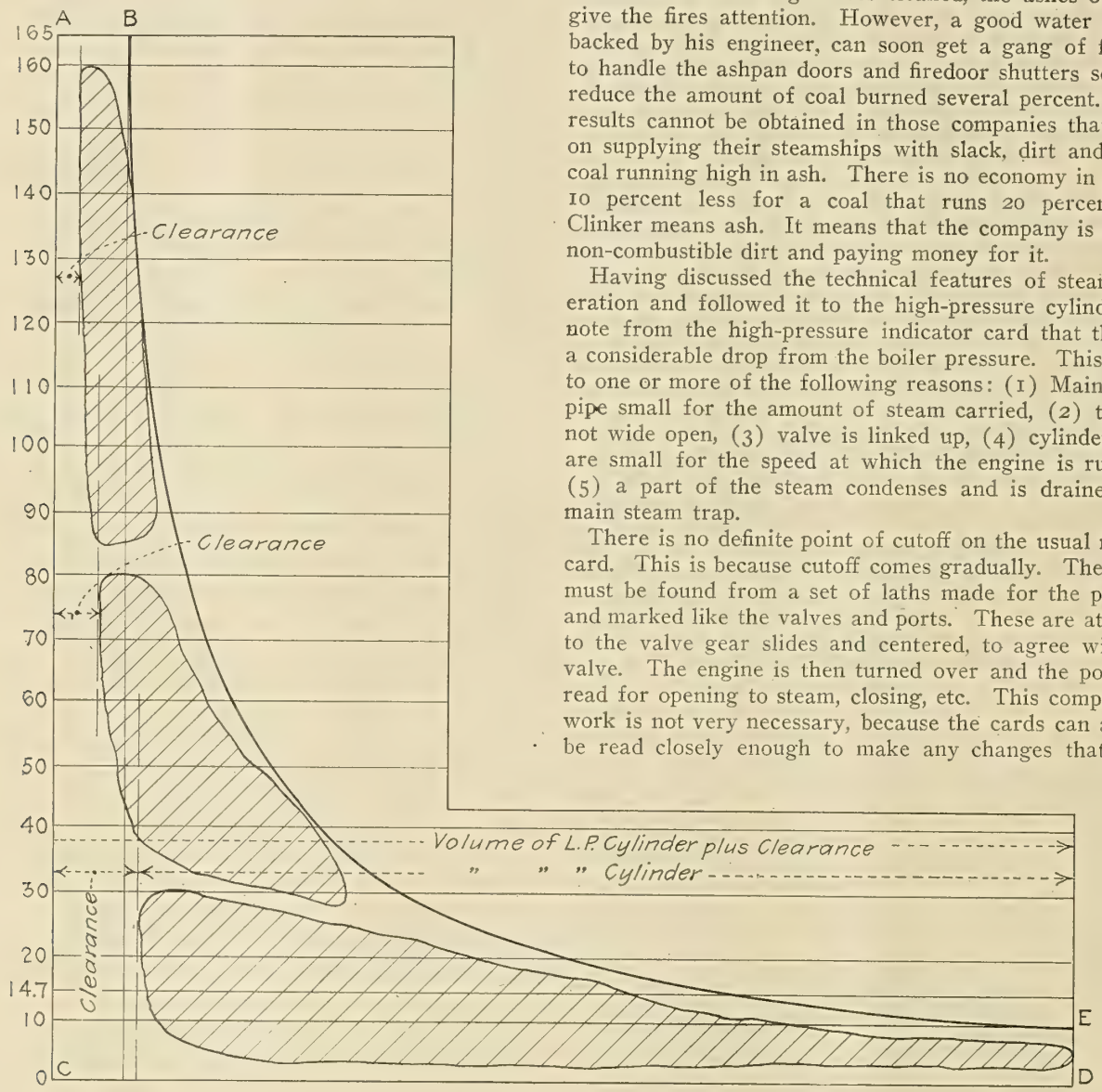


Fig. 2.—Combined Indicator Card

Scotch boilers generally evaporate from 7 to 12 pounds of water for each square foot of heating surface. They have from 5 to 9 square feet of heating surface per boiler horsepower. A boiler horsepower would, for a triple expansion engine, provide steam for an average of 2.5 horsepower, allowing 12 pounds of steam for each horsepower. The ratio of the heating surface to grate surface varies from 16 to 30. The stack temperature of the average Scotch boiler ranges from 700 to 1,000 degrees F. Water-tube boilers are lighter and more efficient than Scotch boilers, but much more expensive as a rule.

Scotch boilers burn from 20 to 40 pounds of coal per square foot of grate surface per hour. They represent the heaviest fires used in steam engineering, the fire bed being from 6 inches to 16 inches thick, and the closest attention is necessary to get efficient combustion. Unfortunately, there is so much hard work, dirt and heat in a ship's stokehold that there is little inspiration for efficient work other than to get fires cleaned, the ashes out, and give the fires attention. However, a good water tender, backed by his engineer, can soon get a gang of firemen to handle the ashpan doors and firedoor shutters so as to reduce the amount of coal burned several percent. Such results cannot be obtained in those companies that insist on supplying their steamships with slack, dirt and cheap coal running high in ash. There is no economy in paying 10 percent less for a coal that runs 20 percent ash. Clinker means ash. It means that the company is buying non-combustible dirt and paying money for it.

Having discussed the technical features of steam generation and followed it to the high-pressure cylinder, we note from the high-pressure indicator card that there is a considerable drop from the boiler pressure. This is due to one or more of the following reasons: (1) Main steam pipe small for the amount of steam carried, (2) throttle not wide open, (3) valve is linked up, (4) cylinder ports are small for the speed at which the engine is running, (5) a part of the steam condenses and is drained into main steam trap.

There is no definite point of cutoff on the usual marine card. This is because cutoff comes gradually. The cutoff must be found from a set of laths made for the purpose and marked like the valves and ports. These are attached to the valve gear slides and centered, to agree with the valve. The engine is then turned over and the positions read for opening to steam, closing, etc. This complicated work is not very necessary, because the cards can always be read closely enough to make any changes that seem necessary. If they cannot be seen, it is not likely that the fault is important.

It is very necessary, though, in order to analyze a steam plant, to know the volumetric clearance of each cylinder. This may be found by careful measurement and calculation of the clearance volume at each end of each cylinder, and the space between the cylinder and the valve in the port passage. Another way is to seal the piston rings with soap or grease and fill the clearance space with water, the amount being carefully measured as it is poured in. The clearance space should be determined in cubic inches. These clearance spaces are the starting point for the analysis of a steam engine plant.

Now taking Fig. 1, trace the curve and two zero lines

on another piece of paper, leaving out the construction lines. This is shown in Fig. 2. The terminal pressure line should be traced, also the initial volume line.

The first thing to do is to put in the atmospheric line, usually at 14.7 pounds pressure. Now the volume of steam, just before exhaust, is the volume of the low-pressure cylinder plus the volume of port, etc., filled with steam. Add these two together and make the total equal to the length of the botom line. Then lay off the clearance on the bottom line.

The clearance for a cylinder with a slide valve will run from 3 to 5 percent, and with a piston valve anything up to 30 percent of the cylinder volume. Divide the low-pressure cylinder volume line into ten parts and draw in the low-pressure indicator card as shown in Fig. 2. In the same way lay off the clearances of the intermediate and draw the cards, measuring everything from the atmospheric line and the clearance lines. The cards will look very different, because the scale one way will look different from the scale the other way. Their length is in terms of volume instead of stroke, and their height is in terms of absolute pressure instead of cylinder pressure. The five-cornered space *ABEDC* represents the theoretical power of steam between 165 pounds and vacuum, and the area of the cards represents the power obtained.

The losses due to clearances, condensation, drop in receivers and imperfect vacuum are clearly visible. If any of the valves were leaking it could be easily seen. If the high-pressure valve leaks, the high-pressure card would show a higher exhaust line. The intermediate-pressure and low-pressure diagrams would rise to the theoretical line, or even rise above it, which is an absolute indication of trouble. If the intermediate-pressure valve leaked, the intermediate-pressure card would fall away from the theoretical line and the low-pressure card would rise in proportion. Also, the exhaust line of the high-pressure would be lower. An exhaust pipe that is too small, or a condenser that is too small, raises the low-pressure exhaust line. Triple expansion engines are usually designed to divide the work evenly between the cylinders, and the cards should be approximately equal in the combined diagram, but no great harm is done if the cylinders develop different amounts of power.

In figuring the steam consumption of a triple engine, it is best to take a point on the high-pressure card where it touches the theoretical line and figure from this, by means of the steam tables, as being the most accurate way, especially as the clearance is here properly included. It is almost impossible to figure steam consumption from an ordinary indicator card unless placed in the combined diagram, because of the error due to clearance, and due, also, to the small scale of the average card. Study and reflection will show how practically any fault with the proportions or adjustment of a steam engine of the multi-stage type can be found on a carefully constructed combined diagram, considered in conjunction with other available data about the boat.

We note from this diagram an average exhaust pressure of 3 pounds absolute. The steam tables tell us that the latent heat at this pressure is 1,015 B. T. U. and the boiling point 141 degrees F., which agrees with practice. Therefore 1,015 B. T. U. will have to be wasted in condensing this steam to water again. Making allowances for slight differences of calculation, we note that we have the same amount of heat as we started with, 1,000 B. T. U., but that it is at a lower temperature and higher latent heat. The condenser removes this heat and condenses the steam, thus allowing the lower exhaust pressure to approach the theoretical. With the exception of a few losses the heat with which the steam started is still in it when it enters the condenser, but in the form of increased latent heat, since the temperature has dropped from 365 to 141 degrees F. The useful power, therefore, might be calculated as follows:

Heat from 1 pound of coal.....	12,500 B. T. U.
Pounds of steam from 1 pound of coal....	10 pounds
Fall of temperature (365 minus 141).....	124 degrees F.
B. T. U. realized in useful work.....	1,240 B. T. U.
Ratio of useful work to original heat.....	10 percent

The last result, as worked out, accords with practice, and is known as the thermal efficiency. Note that although 12,500 B. T. U. is put into 10 pounds of steam, only 1,240 B. T. U. ever comes out. The remainder is thrown into the condenser, as we can easily see, as follows: The latent heat is 1,015 B. T. U. times 10 pounds of water, or 10,150 B. T. U., to the condenser. This, plus 1,240 B. T. U., gives 11,390 B. T. U., which, with the losses from radiation, etc., and the fact that the water enters the condensers hotter than it enters the boilers, accounts for the original 12,500 B. T. U. in the pound of coal.

In examining combined cards, a defective air pump, or one that is too small, will affect the card much the same as a condenser that is too small, but this trouble can always be identified by giving consideration to the condenser area in connection with the amount of steam condensed. If the area is ample and the temperature is normal and the tubes clean, the trouble places itself by elimination on the air pump.

The steam used by auxiliaries can be arrived at very accurately by taking cards on the main engines when the auxiliaries are exhausting into the receivers, and making a combined diagram; then taking another set of cards, when the auxiliaries are exhausting into the atmosphere, and making another combined diagram, and then comparing the two. The exhaust of the auxiliaries very seriously affects the economy of the ship as a whole, and very few engines are properly proportioned in respect to taking care of the exhaust of the auxiliaries into their receivers under the actual operating conditions. Many ships have had large auxiliaries added, such as ice machines, electric lighting plants, etc., and others have had their valve gears changed with respect to the main engines only, no consideration being given to auxiliaries. The horsepower of auxiliaries may not be very great, collectively, but it should be remembered that their consumption of steam is very high. Steam pumps use 50 to 100 pounds per horsepower hour. Slide valve engines use 30 or more pounds, and some engineers regularly leave passover valves open, or partly open, if the ship is crowded for time, and the boilers can make the steam.

Other phases of analysis of marine plants, reduced to a practical basis for the "boys," will follow when our editor feels that he can make room for them. E. N. Percy.

Shipyard Improvements.—A wooden floating dry dock 450 feet long, with a capacity for handling vessels up to 7,500 tons, is being added to the Hunter's Point plant of the Union Iron Works, San Francisco, Cal. At Seattle, Wash., the Skinner & Eddy Shipbuilding Corporation is building a new shipyard double the size originally planned, in order to accommodate the additional business which the company has secured. At Aberdeen, Wash., the Aberdeen Shipbuilding Company, recently incorporated for $10,000 (£2,050), is planning the construction of a small shipbuilding plant. At the Mare Island Navy Yard, San Francisco, Cal., the improvements projected include the addition of a large floating crane.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Best Method of Reducing Power

Q.—Will you please tell me which is the better thing to do when operating for considerable periods of time at half power to get the power reduction by throttling down or by linking in on the reverse shaft? The vessel is equipped with the ordinary Stephenson link gear. P. R.

A.—It is more economical to adjust the valve gear by linking in.

Schools of Naval Architecture and Marine Engineering

Q.—Will you please give me a list of the colleges in this country which give courses in naval engineering? STUDENT.

A.—The institutions of college grade in this country which give courses open to the public in marine engineering and naval architecture are the Massachusetts Institute of Technology and the University of Michigan. Webb's Academy, in New York, also gives courses, and many short, practical courses are given by the various branches of the Y. M. C. A. and shipyards.

Operation of Westinghouse Refrigerating Machine

Q.—Will you please give in your valuable magazine a brief outline of how this new Westinghouse steam jet refrigerating apparatus operates? I cannot see how it is possible by the use of steam to get any temperatures which are low enough to be of any use for refrigeration purposes. R. E.

A.—The underlying principle is that the vaporization of a liquid absorbs a large amount of heat, and the device is one to produce a rapid vaporization, which, being maintained as a continuous operation, ultimately produces temperatures as low as 30 degrees F. The steam jets are simply used as ejectors to produce the very high vacuum in the chamber, where vaporization takes place. The brine is drawn into this vacuum chamber, to which the steam nozzle ejectors are attached, is mechanically atomized, a part of it vaporizes, thereby cooling the remaining liquid, and the vapor is drawn off by the steam jets and is condensed in a separate condenser. The cooled brine is pumped back to the supply tank from which it was drawn, and repeats the circuit.

Area of Rudders

Q.—Can you give me some information as to the areas of rudders for various speeds, lengths and types of ships, in terms of the fraction or percentage of the underwater lateral plane? The only data I have been able to find is given in Simpson's, and is not very complete. I realize, of course, that the actual area for efficient handling of the ship depends upon many factors, such as fullness, stream line flow to the rudder, number of screws, etc., but I would appreciate very much any such practical factors as you can let me have. L. A. B.

A.—Usually the area of rudder to assign to a prospective design is arrived at in no other way than by making a rather rough comparison from some vessel of similar general characteristics which has handled reasonably well in service. There is no scientific method of proportioning a rudder to give any stated turn in a definite time interval. The value given in Simpson for freighters is small, 2 percent being a more common value for moderate-sized vessels that handle well. In general, the greater the size or speed, the smaller the percentage becomes. Naval vessels of large size will have about 2 percent of the immersed lateral plane and 3 percent for moderate size, with about 2 percent for high-speed vessels of the torpedo-boat type. Since steam steering gear has become universal, a deficiency in rudder area except for very slow-speed vessels, is rarely noticed, as the rudder is quickly forced to a greater angle than should be necessary. The lower half of the rudder is more effective than the upper half.

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

Connecting Rod Bearings

Q.—Will you please tell me why the bearing on the crankpin end of the connecting rod is babbitted and the one on the wrist-pin end is not, when they both have to carry the same load? B. B.

A.—The proper area for bearings is obtained by considering both the pressure per square inch and the rubbing speed. If the rubbing speed is low the pressure may be high (1,000 pounds per square inch at wrist-pin end), and if the speed is high the allowable pressure must be smaller (500 pounds per square inch at crank-pin end). For high pressures and low rubbing speeds, as at the wrist-pin bearing, babbit is undesirable.

Remedies for Sparking of Brushes

Q.—Recently the brushes on our generator (D. C. 220 volts) have given a good deal of trouble through sparking, and, so far as I know, no change has been made in the instrument. Can you suggest what is the probable trouble and a remedy for it? E. M.

A.—The trouble may be due to inaccurate brush setting, which can be remedied by (1) grinding the brushes with coarse and then fine sandpaper (not emery) to a perfect fit, and then (2) making the interval between brush sets exactly equal. This latter had best be done by actually measuring the distance between brush sets by a steel tape. The brush pressure should be adjusted to a "happy medium," too little pressure being evidenced by chattering of the brushes and too great pressure by heating of the commutator.

Application of the Theory of Mechanical Similitude

Q.—With a boat model 10.5 inches long and 2.5 inches beam, with an area of 72 square inches on the bottom, nine ounces will cause a difference of .75 inch on the waterline. What weight is required to cause a difference of 12 inches on the waterline in a boat built from this model 21 feet long and 6 feet beam, with a bottom area of 72 square feet? H. E. N.

A.—For problems of this sort there are two things to bear in mind. *First,* that we must deal with similar shapes; that is, the full-sized boat must be exactly the same number of times greater than the model, in length, breadth, draft and all linear dimensions; *second,* that, while the linear dimensions (length, breadth, draft, etc.) go up in this proportion, the area of surfaces goes up proportional to this scale squared (multiplied by itself), while the displacement and volume go up proportional to this scale cubed (multiplied by itself twice). For example, if we have a small cube 12 inches on a side and we wish to consider one 12 feet long, *all* dimensions must be 12 times as great and the volume of the large cube will be $12 \times 12 \times 12$ as great. In the same way, if a rectangular solid 3 inches broad by 10 inches long by 2 inches deep is to be increased to one 24 times as large, *every* linear dimension goes up in that proportion, and the large solid becomes 6 feet by 20 feet by 4 feet, and its volume is $24^3 = 13{,}824$ times as great. This same conception holds for a boat. From the dimensions of your model you cannot get all the

dimensions quoted for the full-sized boat by multiplying by *one* factor of magnification, and so conclusions for a boat of these dimensions cannot be drawn from this model. If we were to have a boat exactly similar to the model and 21 feet long it would be 24 times as large and would have to have a beam of $24 \times 2.5 = 60.0$ inches or 5 feet, instead of the 6 feet quoted. For a boat of this sort, which is similar to the model, it would take $9 \times 24^3 = 12{,}400$ ounces, or 7,780 pounds, to increase the waterline $\frac{3}{4} \times 24 = 18$ inches.

Length and Breadth to be Used for Hull Coefficients

Q.—In calculating the following molded coefficients what is the proper length and breadth to use and the reason for that choice? The coefficients are, the block, midship section, prismatic and water plane. The coefficients are to be computed for a distance below and above the normal load waterline. The midship section may have a flare, or it may have a "tumble home" beginning below the normal waterline; the stem may be straight or it may be of the clipper-bow type; the stern may extend beyond the after perpendicular as in the *Lusitania*.

With the exception of Biles' "Construction and Design of Ships" I can find no information on the above subject. Most books refer to the normal load waterline condition, but Biles says to use the length between perpendiculars and the molded beam, keeping these dimensions constant. C. A. F.

A.—The selection of the proper length presents more difficulty than beam and draft and no fixed rule can be given which will hold for all types. In general the length to be used for block, prismatic and water line coefficients should be the one which gives the nearest approximation to the *extreme length* of the *hull proper* (exclusive of rudder, propeller aperture, etc.) when in *normal loaded condition.* For immersions greater or less than this no other length should be used, as usually the actual changes in length due to varying immersion affect the resultant coefficients but slightly and the coefficients for the other immersions are of less importance.

The extreme perpendiculars arbitrarily accepted by the various shipyards usually serve as the limits for measurement and may diverge appreciably from that suggested above. It is worth while, however, to bear in mind that the displacement determination is rarely accurate closer than 2 percent, so that great refinement is unnecessary. For example, the error injected into the block and other coefficients involving length by taking the length to the rudder-post instead of to the stern-post of a steam vessel with a propeller aperture coming well above the load water line might be for a 400-foot ship about 6 feet, or 1½ percent. If the length be taken as first suggested it has the further advantage of being the proper length to use in resistance calculations.

The beam used should be the *extreme molded beam* of the hull *below the normal load waterline.* If there is an excessive flare beginning below the load waterline judgment must be used, but usually the molded beam *at the waterline* should be selected for this case.

For a vessel with a level keel line the *extreme molded draft* should be used, and for keels with a drag the *mean draft,* except in the case of the midship section coefficient, which should be determined from the extreme molded draft *at the midship section.*

Size of Low-Pressure Piston Rods

Q.—Will you kindly explain why and by how much the piston and connecting rods of low-pressure cylinders may be reduced in size? Assistant Engineer.

A.—In a triple-expansion engine it is normally desired that one-third of the work be performed by the high-pressure cylinder, one-third by the intermediate and one-third by the low. When the low-pressure cylinder is divided into two that means that the work done in each cylinder is normally one-sixth of the total indicated horsepower of the engine. In this case the rods for the low-pressure cylinders are properly of reduced size, as they are performing less work. The reduction is usually about 40 percent in diameter. With the present proportions of cylinder volumes in use with triple-expansion engines it is doubtful if any radical change is made in the distribution of work by the change of location of the cylinders, and there appears to be no theoretical reason why the rods should not be reduced, whatever the arrangement of the cylinders may be. Frequently, from the operating point of view, it is desirable to have all rods of the same external diameter, in which case, when hollow rods are used, the holes in the low-pressure rod may be of greater size than those in the high and intermediate.

NEW BOOKS FOR MARINE ENGINEERS

Johnson's Steam Vessels of the Atlantic Coast. Size, 8¼ by 4½ inches. Pages, 204. New York, 1916: Eads Johnson Publishing Company. Price, $5.

In recent years Mr. Eads Johnson, naval architect, New York, has published annually a very convenient pocket list of the steam vessels entering New York harbor. The demand for this book and its recognized value have led to the publication this year of the first edition of a similar book covering the steam vessels of the Atlantic coast. In this book the publishers have furnished to the marine trade a complete and accurate list of the mercantile steam vessels of American register on the Atlantic seaboard, together with the principal particulars of each vessel, such as date and place of construction, dimensions of hull, tonnage and types and sizes of engines and boilers. All this information is given in such form as to be convenient and instantaneously available. The lists are arranged as follows: First, list of owners; second, list of vessels with their owners; third, list of former names of vessels with present names; fourth, steamship companies and owners with their vessels in detail.

Mechanical Engineers' Pocketbook. Ninth Edition. By Wm. Kent, M. E., Sc. D. Size, 4 by 6¾ inches. Pages, 1,526. Illustrations, over 250. New York, 1916: John Wiley & Sons, Inc. Price, $5 net.

Since the eighth edition of this book was published, five years ago, there have been notable advances in many branches of engineering rendering obsolete portions of the book which at that time were in accord with practice. In addition, many engineering standards have been changed during the five-year period, necessitating a thorough revision of many sections of the book. The absolutely necessary revisions to bring the book up to date have involved changes in over 400 pages of the eighth edition and the addition of over 150 pages of new matter. The treatment of many of the subjects in the earlier edition has been condensed into smaller space to enable the insertion of the new matter without increasing the size of the book to unwieldy proportions, with the result that the new edition actually contains only 64 more pages than the previous edition.

Extensive revisions have been made in the subjects of materials, mechanics, fans and blowers, heating and ventilation, fuel, steam boilers and engines and steam turbines. The chapter on machine shop practice has been rewritten and practically doubled in size. The new matter includes additional data on planing, milling, drilling and grinding, together with an elaborate treatment of the subject of machine tool driving. The subject of electrical engineering has been completely rewritten. A valuable feature of the new edition is the addition of numerous tables, giving the latest standards for various engineering materials. Indispensable as this book has become, a copy of the new edition should find a place in every engineer's library on account of the value of the new matter which it contains.

Marine Articles in the Engineering Press

Standardization of Stability Curves—Calculations for Stability of Vessel in Damaged Condition—Propeller Mysteries

The World's Shipbuilding in 1915 (*excluding warships*).—Excluding all vessels intended for naval purposes, 327 vessels of 650,919 tons were launched in the United Kingdom in 1915. Of these vessels, 317, aggregating 648,629 tons, were steamers, and 10, aggregating 2,290 tons, were sailing vessels or barges. The output of the mercantile tonnage in the United Kingdom during 1915 shows a decrease of 1,032,634 tons, as compared with that of last year. Of the total output, nearly 85¼ percent has been built for registration in the United Kingdom. The largest vessel launched during the year was of 13,400 tons, 3 were over 10,000 tons each, and 33 over 6,000 tons each. The average tonnage of steamers launched in the United Kingdom during 1915 is 2,046 tons, but, if steamers of less than 500 tons are excluded, the average of the remaining steamers reaches 3,791 tons, which is a considerable reduction as compared with the mean of the averages of the five previous years. Six steamers were launched, with a total tonnage of 53,192, which will have Parsons geared steam turbine engines. Two vessels, with a total of 10,700 tons, were fitted with internal combustion engines. Seven vessels, with a gross total tonnage of 43,665, were built on the Isherwood system of longitudinal framing. Five steamers of 31,684 tons were for the carriage of oil in bulk. Eight vessels of 66,334 tons were built with cruiser sterns. The output of the leading districts was as follows: The Clyde, 205,073 tons; the Tyne, 124,001 tons; the Wear, 110,942 tons; Hartlepool, 59,308 tons; Middlebrough, 58,574 tons, and Belfast, 33,729 tons. Incomplete statistics show that outside of the United Kingdom 416 vessels of 550,719 tons were launched during the year, which represents a decrease of nearly 53 percent, as compared with the figures for 1914. 7 tables. 1,200 words.—*Lloyd's Register of Shipping,* January.

The Standardization of Stability Curves.—By Wilfrid Ayre. Apart from the primary object of investigating and diagrammatically representing the stability of a particular vessel, much information of great technical value can be obtained from curves of statical stability, provided they are reduced to a common basis or standardized in such a manner as will permit of their being readily applied to other vessels whose dimensions, proportions and form have been reduced to a standard comparative basis. It is usual to construct ordinary curves of statical stability, the ordinates of which represent values of righting arm or righting moment at various degrees of inclination. It is also customary to construct cross curves of statical stability, each showing the variation of righting arm or righting moment for fixed angles of inclination to the upright and varying displacement. Neither the ordinary curves nor the cross curves are capable of being readily applied to another vessel during, for instance, the designing stages when the exigencies of time forbid the construction of actual curves for the various range of dimensions which may be proposed. The principal object of this paper is to describe a method of standardizing statical stability curves of form which is thought to be of value in designing vessels by providing reliable means to construct curves for various dimensions and conditions proposed without incurring the construction of body plans. The second object of the paper is to illustrate the fact of systematically varying the proportion of beam and depth and of increase or decrease in the fullness or fineness of form. The author hopes that the suggestion of standardizing information already obtained, and its subsequent use as outlined in the paper, may be a means of contributing to an increased tendency to give fuller consideration to the supremely important question of the stability of ships. 22 illustrations. 3,250 words.—*Transactions of the North East Coast Institution of Engineers and Shipbuilders,* February.

The Time Element and Related Matters in Some Ship Calculations.—By Professor J. J. Welch. In estimating the stability and trim of a vessel after specific damage, attention is generally confined to the results of calculations for the particular case, where the total loss of buoyancy resulting from the damage has been compensated for by deeper immersion of the vessel, and on these results opinion is based as to whether the ship will be safe or not after such damage; but at some intermediate time before the calculated final condition is reached it may happen that other conditions supervene which render the conclusions drawn from that calculation invalid and it becomes necessary, therefore, to study intermediate conditions through which the vessel passes to insure that no factors will be introduced which will vitiate the final result. Two illustrations of this are given, floating bodies of regular form being taken for the sake of simplicity and some closely related questions are briefly discussed. The first case is that of a box-shaped vessel 200 feet long, 30 feet wide, floating at 10 feet draft and having its C. G. 11.8 feet above the keel, when a central transverse compartment 50 feet long assumed empty is opened up to the sea. An investigation is made to learn if this vessel will be stable after damage and free from danger in still water with a row of side lights open, the lower edges of which are 15 feet above the keel. The ordinary calculations for the final condition of the vessel would lead to the conclusion that the ship would be stable after damage and safe under the conditions assumed with the ports open; but it is well known that in the early states of the filling of such a compartment there will be a decided fall in the position of the virtual metacenter. In the early stages the stability will be inactive and the ship will evince a tendency to "loll," and, if the hole through which the water enters is of comparatively small dimensions there would be an appreciable time for the list to develop. The investigation of this action shows that at some intermediate time the ship will attain a position in which the lower edge of the port holes are practically 9 inches below the water, and, therefore, in actual practice the vessel would be unsafe under the conditions assumed. Another case mentioned where the element of time has an influence on the final result is that of the box-shaped vessel previously mentioned, but with the C. G. 10.5 feet above the keel to insure transverse stability during flooding, to have two end compartments, each 25 feet long. An investigation is made of the results in the event of the foremost compartment being bilged by collision. The extreme case is assumed, that of the forward compartment being first opened to the sea, and then, after that has been filled, the after compartment is opened. The final calculated results will always be the same, but supposing that the inner bulkheads of the end compartments terminate 15 feet above the keel and the end compartments are not

filled uniformly, the vessel might take up a position in which the water would be several inches above the top of the inner bulkhead of the foremost compartment and would overflow into the adjacent compartments, with subsequent foundering of the vessel. Such considerations have an important bearing upon the question of providing flooding or pumping appliances to introduce water at one end of the vessel to correct trim due to damage to the other end, with a view to improving the chances of safety of the vessel. In any event, in certain classes of ship calculation problems it is not always sufficient to consider the result of the usual conclusions relating to the time when the loss of buoyancy involved by damage is finally restored, but regard must also be paid to the position and condition of the vessel at intermediate times, since factors may be introduced at such stages which render the results of the usual conclusions unattainable in practice. 6 illustrations. 4,700 words.—*Transactions North East Coast Institution of Engineers and Shipbuilders,* January.

The Mystery of the Screw Propeller.—By Captain C. W. Dyson, U. S. N. For many years after the adoption of the screw propeller for the propulsion of ships the seeming vagaries in its performances in actual service of propulsion have cast a mystery over it and over the laws governing its action. The greater part of this mystery is, however, not due to the propellers, but can be directly laid upon the carelessness with which the trials of ships have been run and data collected, while the greater part of the remainder can be attributed to the effect of variation in hull form in interfering with the proper flow of water to the propeller, thus seriously decreasing the propulsive efficiency; in producing more or less wake and so adding to the propulsive efficiency; in incorrect estimate of effective horsepowers required for given speeds, basing these powers on estimates of frictional and residual resistances with an entire neglect of the influence of appendages, such as struts, bilge keels, etc. The small remaining portion of the mystery may be ascribed to the propeller itself and is due to the myriad variations in blade form and section which have been used, these appearing to depend upon the taste of the designer and upon the lack of a consistent basis of comparison for the analysis of the propeller performances. As time passed, the model tank by which a more nearly accurate value of the effective horsepower may be obtained became available, also more accurate instruments for the measurement of indicated and shaft horsepower, better mechanical construction of propelling engines by which frictional losses have been greatly reduced and brought to a more nearly competent and even value; more care in running trials over the measured mile, combined with a better knowledge of the effect of shallow water on the course, both tending toward the production of better data, and these improvements have resulted in the production of data from which curves of analysis may be drawn, rendering it possible to take any propeller which may be proposed for a given vessel and to estimate a curve of performance for any condition with more than a fair degree of accuracy. The comprehensive discussion which the author gives, together with rules and examples as a partial explanation of the mystery of the screw propeller, shows that the efficiency of the performance of the propeller is seriously affected by its position in relation to the hull of the vessel which it is driving and by the fullness of the hull lines at the after body; that for any given propeller working under constant hull conditions of form the effective horsepower for any given engine power remains constant, and this is independent of the speed of the vessel; that for any given propeller, working under constant hull conditions of form, the revolutions necessary to deliver any given effective horsepower vary with the speed of ship, the engine power remaining constant; that model tank effective horsepower curves are correct and that the appendage resistance varies according to the "law of comparison"; that trials of vessels over shallow water courses should be prohibited, as such courses vary entirely the character of the water flow to the propellers; that deep water trials, by the close agreement of actual with estimated results, demonstrate the correctness of the above statement; that the large estimate of from 3 to 5 percent error usually accredited to torsion meters and indicators used on official trials is incorrect, particularly at high power; that results obtained from model tank experiments with model propellers will be correct when the model is properly proportioned to the full-sized propeller, which does not mean that the fixed ratio of the propeller and of the model shall be the same, and the chart condition of the model propeller working with no hull, or rather behind a phantom ship can be calculated, and, finally, that where vessels are entered into competition based upon relative efficiencies of their propelling machinery, it is a positive error to base these efficiencies upon speed or revolutions, as both speed and revolutions for equal loads upon the propellers represented by equal effective horsepowers vary with the loading of the hull, foulness of ship's bottom, weather and sea, while the engine power for this effective horsepower remains constant, except in cases where propellers are foul or their blades distorted. It shows, therefore, that the true criterion for efficiency of propelling machinery should be indicated or shaft horsepower developed by that machinery and that the speed of ships and revolutions of propellers should be neglected. 5 illustrations. 20,000 words.—*Journal of the American Society of Naval Engineers,* November.

Turbine Machinery of the Steamship Bingera.—A highly interesting piece of work was recently carried out by Messrs. McKie & Baxter, of the Copland Works, Govan, consisting of the replacement of the turbines of the steamship *Bingera* with triple expansion reciprocating engines. The *Bingera* is a vessel of 2,092 gross tons, 300 feet 3 inches long, built in 1905 for the passenger and cargo trade of the Australian coast. The original propelling machinery, consisting of a three-shaft arrangement of steam turbines designed to drive the vessel at a speed of from 16 to 17 knots, proved unsatisfactory. The owners therefore decided to remove the turbines and fit three sets of reciprocating engines, operating at a lower speed than was necessary for the economical operation of the turbines. The reciprocating engines have cylinders 15 inches, 24 inches, 27 inches and 27 inches in diameter by 21 inches stroke, running in ordinary service at 225 revolutions per minute, developing 3,000 indicated horsepower. The vessel is now in service and is giving excellent results, a special feature being the entire absence of vibration with the four-crank triple expansion engines. The alteration seems to be justified by an increase of speed, together with a saving of coal. 10 illustrations. 600 words.—*Engineering,* December 17.

Men of the American Merchant Marine.—Returns to the Bureau of Navigation, Department of Commerce, show that on June 30, 1915, the 26,701 merchant vessels of the United States documented for foreign or domestic trade were manned by 152,133 officers and men, excluding masters. Including the masters, and also the men and officers manning yachts, there is a grand total of 187,921 officers and men for 28,257 documented merchant vessels and yachts, aggregating 8,487,331 gross tons.

Shipbuilding and General Marine News

Contracts for New Ships—Marine Terminal Improvements—Recent Launchings—Improved Appliances—Personal Items

One of the most important announcements made during the past month was that of the completion of plans for the complete reorganization of the American Bureau of Shipping with a view to placing this classification society upon a substantial foundation both technically and financially. This reorganization has the enthusiastic support of all classes interested, particularly shipowners, shipbuilders, naval architects and underwriters, who have all joined together to make the American Bureau a classification society having a reputation that will command the respect of the world.

American maritime interests are to be congratulated upon the election of Mr. Stevenson Taylor, president of the Society of Naval Architects and Marine Engineers, as president of the Bureau. Mr. Taylor's acceptance of this post is ample assurance that American shipping interests will be thoroughly protected by an efficient and progressive American classification society conducted on broad administrative and scientific lines. The Bureau is further strengthened by the election of Mr. Antonio C. Passano, president of the Great Lakes Engineering Works, as first vice-president and Mr. Frank G. Macomber, a well-known marine underwriter, of Boston, as second vice-president. The former secretary of the organization, Mr. John W. Cantillion, has been elected secretary and treasurer.

In addition to his duties as president, Mr. Stevenson Taylor has temporarily assumed the duties of supervisor of the Bureau, that office having been vacated by its former incumbent.

Contracts for New Ships

The American Shipbuilding Company, Cleveland, Ohio, has received a contract from the Mallory Steamship Company, New York, for four steamers of Welland Canal size, to cost about $1,300,000 (£267,000), and a contract from the Standard Oil Company, New York, for an oil tanker.

Including the above, the American Shipbuilding Company now has twenty-six ships ordered or under construction.

The Great Lakes Engineering Works, Detroit, Mich., has received a contract from M. A. Hanna & Company, Cleveland, Ohio, to build a 12,000-ton ore carrier.

The New York Shipbuilding Company, Camden, N. J., has contracts for two ships for parties whose names have not been made public.

The Seattle Construction & Dry Dock Company, Seattle, Wash., has a contract from Norwegian interests for the construction of two steel freight steamships of 7,500 tons deadweight capacity.

The Manitowoc Shipbuilding Company, Manitowoc, Wis., has received a contract from the Bay State Fishing Company, Boston, Mass., to build three power trawlers of 300 tons each.

The Gas Engine & Power Company & Chas. L. Seabury & Company, Consolidated, Morris Heights, N. Y., is building a 52-foot motor yacht for A. Selwyn, Rowayton, Conn.

Bowes & Mower, Philadelphia, Pa., have designed a 78-foot electrically driven yacht for O. J. Dale, Barengat, N. J.

The Robins Dry Dock & Repair Company, Erie Basin, Brooklyn, N. Y., will make extensive alterations to the steamship *Porto Rico,* now owned by the Bluefields Fruit Company, Bluefields, Nicaragua.

The Buffalo Dry Dock Company, Buffalo, N. Y., will cut in two the steel steamer *H. H. Brown,* preparatory to fitting her out for salt-water navigation.

It is reported from Portland, Ore., that the Willamette Iron & Steel Works and the Northwest Steel Company will co-operate to build a shipbuilding plant in Portland to cost about $1,500,000 (£308,000), and that orders have already been practically closed to build two steamships for Norwegian interests.

New Company for Designing Efficient Screw Propellers

A new company, known as the American Screw Propeller Company, with offices at 1520 Sansom street, Philadelphia, Pa., has just been formed for the purpose of designing efficient screw propellers for any type of seagoing or air craft. The method of design which this company will use is the Dyson method and Captain Charles W. Dyson, U. S. N., the inventor of this method, will be one of the consulting engineers of the company, together with Luther D. Lovekin, M. E., chief engineer of the New York Shipbuilding Company, as his associate, and Rear Admiral A. B. Willets, late director of the United States Navy Yards, as director.

The company will undertake to furnish designs for the best possible propeller for any vessel whose owner or builder can provide the necessary hull data. The business of the company will be international and correspondence is invited from all interested in propeller economy and efficiency.

New Shipyard on the Delaware River

The Pennsylvania Shipbuilding Company, recently organized with a capital of $600,000 (£123,000) and with offices in the Land Title building, Philadelphia, Pa., has purchased a site with an 800-foot waterfront at Gloucester, N. J., for erecting a new shipyard. Contracts have already been secured by the new company for the construction of six freight steamers each about 350 feet long of 12 knots speed to be driven by geared turbines. Contracts for steel plates for this work are being made for delivery at the rate of 600 tons a month, and it is expected that two of these ships will be ready for delivery within eighteen months after the yard is opened. The company already has sufficient work to keep it fully occupied for at least two and a half years.

The officers of the company are H. E. Norbom, of Philadelphia, president; Charles H. Moyer, of Philadelphia and New York, vice-president, and George S. Hoell, secretary-treasurer. Henry Lysholm, for many years superintendent of the hull department of the New York Shipbuilding Company, has been appointed general manager. About 450 men will be employed in the new plant.

Plans for the new yard provide for a basin 120 feet wide and 800 feet long, with building berths on each side arranged for side launching so that two vessels can be laid down on each side of the basin at the same time. Later it is expected to construct another basin alongside the first one, doubling the capacity of the yard. Plate and machine shops will be erected at the end of the basin,

together with a complete crane system for conveying material and for serving the building berths. Electric power supplied by the municipal power plant will be used throughout the plant, individual motors being provided for the machine tools in the plate shop and group drive in the machine shop.

At present the plant will be devoted to hull work only, contracts for the machinery for the vessels built being sublet to outside manufacturers.

Inspection of the Twin Screw Werkspoor Diesel-Engined Tank Ship Ares

During the recent visit to New York harbor of the Dutch motor tank ship *Ares,* built last year by the Netherlands Shipbuilding Company, Amsterdam, and fitted with two sets of six-cylinder Werkspoor Diesel engines, developing a total of 1,650 brake horsepower, Mr. T. Orchard Lisle, American representative of the Werkspoor Works, builders of the engines, conducted a party of prominent ship owners, shipbuilders and engineers on a tour of inspection of the vessel.

The *Ares* is 347 feet long, 46 feet beam, 27 feet 6 inches molded depth, with a draft of 22 feet, a displacement of 7,720 tons and a deadweight capacity of 5,050 tons. The vessel was designed for a service speed of 10¼ knots, but on trial developed a speed of 11¼ knots. The engines, which weigh 96 tons each, have cylinders 20½ inches diameter by 35½ inches stroke and operate on the four-cycle principle at from 115 to 125 revolutions per minute. The loaded fuel consumption of the vessel, including auxiliaries at sea, has proved to be not over 7 tons per 24-hour day, the coal consumption per indicated horsepower hour being from .316 to .326 pound. The vessel has a bunker capacity of 692 tons, giving a cruising radius on one load of fuel of 22,800 nautical miles.

It will be remembered that two of the largest shipyards in the United States, the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., and the New York Shipbuilding Company, Camden, N. J., have obtained licenses to build this type of Diesel engine in this country.

Interesting Transfer of Vessel Property

A strong indication of the urgent necessity for additional tonnage to take care of the immense shipments to be handled may be seen in the recent action of the Standard Oil Company in purchasing from the Smith Shipping Company a fleet of six freight vessels now under construction from the designs and under the superintendence of Messrs. Cox & Stevens, New York, at the yards of the Toledo Shipbuilding Company, Toledo, Ohio.

In August, 1915, the Smith Shipping Company, anticipating an unusual demand for vessels, placed through their naval architects, Messrs. Cox & Stevens, an order with the Toledo Shipbuilding Company for six vessels to carry 3,000 tons deadweight, to be propelled by heavy oil engines and to have in addition a sail plan capable of driving the vessels at a satisfactory speed under ordinary conditions at sea.

This fleet is now well under construction, and will be completed and ready for delivery shortly after the opening of navigation on the Lakes.

While it is not generally known what price was paid by the Standard Oil Company for acquiring these vessels, it may be safely said that the Smith Shipping Company would not have parted with them under present conditions without receiving an enormous profit over their investment, for the reason that the present earning capacity of these ships is so great that they will probably be able to make for their owners the entire first cost within less than one year of service.

The Standard Oil Company has the reputation of being very farsighted in all their business arrangements, and the fact that they have found it advisable and necessary to purchase these vessels is a clear indication of the great shortage of tonnage existing, and shows that even the prevailing high rates asked for available vessels will not deter operators from acquiring them.

New Steamship Companies

The Kentucky-Indiana Packet Company has been organized, with a capital of $10,000 (£2,050). The incorporators are F. N. Spellman, B. M. Green, Stephen Green and H. C. Tiedeman, all of New Albany, Ind.

The Pan-American Petroleum & Transport Company has been organized in Delaware, with an authorized capital stock of $150,000,000 (£30,750,000). The new corporation is a consolidation of several companies, among them being the Mexican Petroleum Company, New York. It is understood that E. L. Doheny, president of the Mexican Petroleum Company, will act as president of the Pan-American Petroleum & Transport Company. It is reported that the new company has already asked for bids for several oil tank steamships.

The Interlake Steamship Company, Cleveland, Ohio, controlled by Pickands Mather & Company, Cleveland, has purchased thirteen vessels belonging to the Cleveland Steamship Company. The Interlake Steamship Company's fleet now comprises fifty-two boats, and it is reported that the company will build several additional ships in the near future.

W. K. Greenbaum, president of the Indiana Transportation Company, Chicago, Ill., is considering establishing a regular steamship service between Atlantic City, N. J., and New York.

The Southern Transportation Company has been incorporated to engage in water transportation. The incorporators are H. Spielberg, S. Ranch and B. Bernstein, 100 Clark street, Jersey City, N. J.

Marine Terminal Construction and Improvements

The C. Reiss Coal Company, Superior, Wis., will soon award a contract for building a dock to cost about $300,000 (£61,500).

S. W. Bowen, chief designing engineer, St. Louis, Mo., has drawn plans for establishing a municipal dock and warehouse at the foot of North Market street, at an estimated cost of $255,000 (£52,250).

The Canadian Locomotive Company, Kingston, Ont., Canada, has applied for permission to build a 400-foot pier in Kingston Harbor.

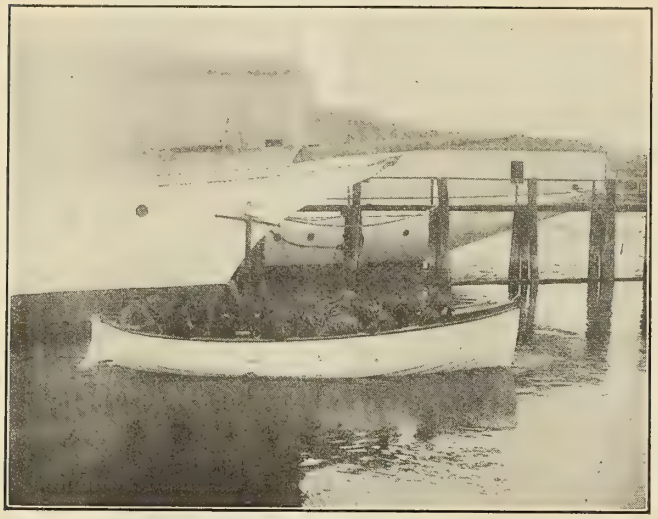
The Sinking Fund Commission of the city of New York has adopted the plans of Dock Commissioner R. A. C. Smith, Pier A, North River, New York, for the improvement of the water front on the East River between State and Orange streets, Brooklyn. The plan is for eight piers varying in length from 585 to 660 feet, to be built by the New York Dock Company, State and Whitehall streets, New York.

Aimsworth & Dunn, White Building, Seattle, Wash., are preparing plans for the reconstruction of Pier 14, Seattle, at an estimated cost of $30,000 (£6,150).

The General Chemical Company, New York, has awarded a contract to John Monks & Son, New York, to build a pier at Marcus Hook, Pa., to cost about $200,000.

Motor Lifeboats

The illustration shows a 24-foot motor lifeboat, as built by the Welin Marine Equipment Company, Long Island City, New York, in both wood and steel, in compliance with the general rules and regulations of the Board of Supervising Inspectors of the United States Steamboat Inspection Service. These boats have a beam of 7 feet 3 inches and a draft of 3 feet 3 inches. The motor, a 2-cylinder, 4-cycle, 4½- by 5-inch Speedway engine, is



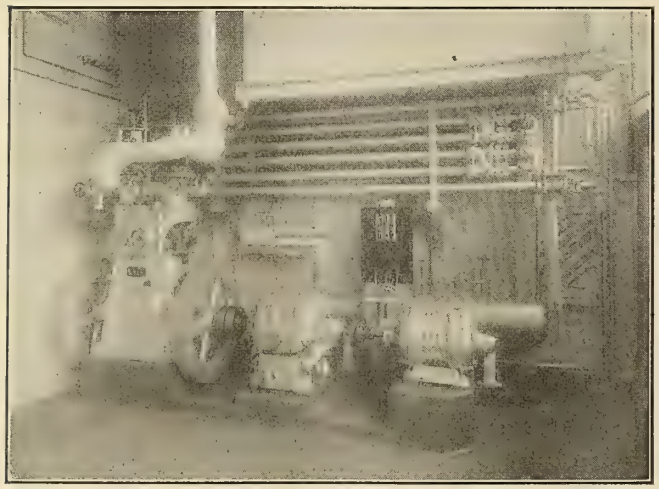
24-Foot Motor Lifeboat

installed in a thoroughly protected watertight inclosure. A 40-gallon gasoline (petrol) tank is installed under the forward deck, while galvanized iron air tanks are installed under the seats and the after deck. A water tank of 15 gallons capacity is placed forward of the engine.

The steel launches are constructed of No. 16 B. W. G. steel, the keel, stem and stern post being of flat steel. The wood launches are of lap strake construction, having ½-inch cypress planking, and the frames and keel of oak. Lifting tackles are arranged at the bow and stern.

A Turbo-Gear Installation

The illustration shows an installation of the "internal herringbone" gear reducer manufactured by the Turbo-Gear Company, Baltimore, Md., connecting a Frick Company ammonia compressor with an electric motor running at 1,800 revolutions per minute, the speed reduction being



Turbo-Gear Installation

13 to 1. An efficiency of 98 to 99 percent is guaranteed at full load on any turbo-gear having a single train of gears. With the single train of gears, speed ratios as high as 30 to 1 can be obtained. The chief reason for the superior qualities of this gear, it is claimed, is the combination of two ideal conditions in gearing—namely, that of an internal gear with its long arc of contact with corresponding easy approach and recession, and that of the helical gear with its continuity of action. The turbo-gear was primarily developed for use in connection with steam turbines, centrifugal pumps and kindred machinery, but a much larger field of application has been found in connection with electric motors, as illustrated in this case. The advantages claimed for this mode of power transmission include savings of from 20 to 25 percent in power costs over other drives, less floor space, elimination of strains on bearings of the motor or prime mover, since the driving and driven shafts are in one line, and lower initial costs. These transmissions are manufactured in sizes from 5 up to 1,000 horsepower.

Skandia Marine Oil Engines

The Skandia marine oil engine, manufactured by Messrs. Lysekils Mek. Verstads Aktiebolag, Lysekil, Sweden, has been placed on the market in the United States by the Marine Oil Engine Company, Inc., 30 Church street, New York. The Skandia is a two-cycle hot-bulb engine, which runs on heavy crude or residue fuel oil. It has been widely used throughout the world during the last eighteen

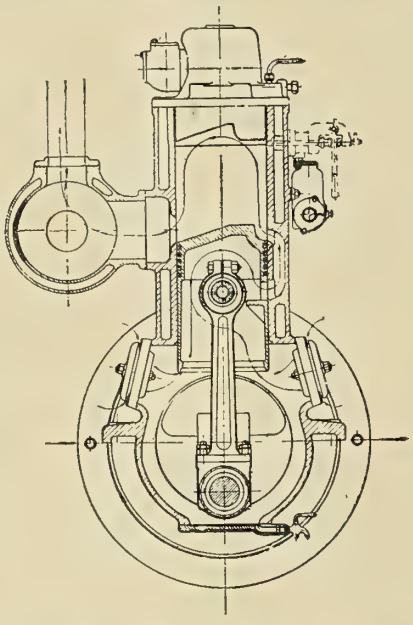


Fig. 1.—Section Through Cylinder of *Skandia* Engine

years, over 250,000 horsepower of these engines having been put on the market during that time, covering installations in tugboats, auxiliary schooners, small freight and passenger boats, fishing craft, revenue cutters, pilot boats and various government vessels. The simple construction, remarkably low consumption of fuel and the small attention required for operation (engines of this type having frequently been put in the hands of persons who have no knowledge of machinery and operated successfully) make the Skandia a most popular type of marine oil engine for work boats.

Three types of reversible Skandia engines are built. In the direct reversible engine (Fig. 2), which is built in sizes of from 60 to 500 horsepower, the reversing and

starting is effected by means of air produced by an air compressor. The maneuvering from full speed ahead to full speed astern requires only two manipulations. On each cylinder there is a maneuvering valve and a cock and on the lay shaft are cams for driving each valve ahead and astern. By drawing back a single handle all the relief cocks are opened at the same time. The cams are controlled by bringing the lay shaft forwards or backwards by means of a lever. The compressor for supplying air for starting and reversing is mounted, together with the circulating pumps and bilge pumps, in a single casting

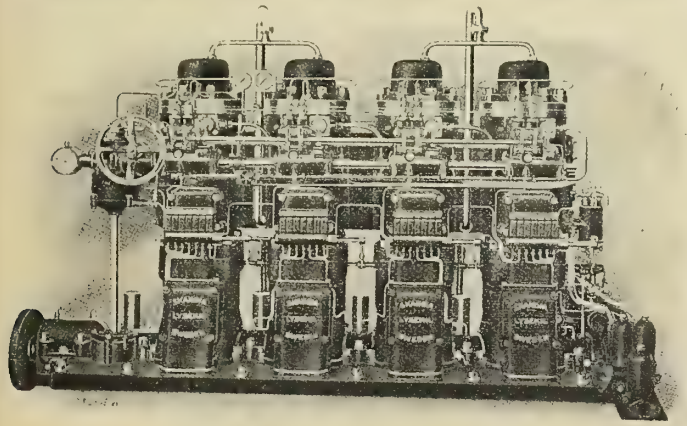


Fig. 2.—240 Horsepower Direct-Reversible Skandia Engine

forward of the first main bearing, and is driven by a special patent drive.

In the smaller engines reversing is accomplished either by a special reversing gear or by reversible propeller blades.

All Skandia engines are supplied with a governor in direct connection with which is the fuel pump worked through the medium of a cam. By means of an adjusting screw combined with the governor, the fuel feed may be regulated instantaneously while the engine is running and after the stroke of the pump has been adjusted to suit the load on the engine it will run continuously with the same number of revolutions. The governor makes it possible to regulate the speed of the engine from any position in the boat. A positive and reliable lubricating system is also provided.

Tests of a 25 brake horsepower, one cylinder Skandia marine engine recently made by the Material Testing Section of the Chalmers Institute, Gothenberg, showed a fuel consumption of only .56 pound per brake horsepower hour. With larger engines, this fuel consumption is greatly reduced.

Not only has the Marine Oil Engine Company, Inc., secured the sales rights of the Skandia engine in the United States, but also the exclusive manufacturing rights, and the company is now entering upon the construction of these engines on a large scale, having already placed orders for a number of the engines. They have also made arrangements with J. H. Hansen & Co., San Francisco, to act as exclusive Pacific coast agents for the company.

Launch of the United States Tug Wando.—The United States tug *Wando* was launched at the Navy Yard, Charleston, S. C., on March 7. The sponsor was Miss Anne Bryan, daughter of Captain B. C. Bryan, U. S. N., commandant of the yard. The *Wando* is the largest vessel that has been launched at the Charleston Navy Yard, and it is expected that its construction will be followed by many other and larger vessels.

PERSONAL MENTION

Thomas E. Brown, consulting engineer, New York, has removed his office from 17 Battery Place to 18 East Forty-first street.

Oscar R. Cauchois has been appointed general agent of the Compagnie Générale Transatlantique at New York vice Mr. Paul Faguet, retired.

Captain C. A. McAllister, engineer-in-chief of the United States Coast Guard, was appointed on March 4 for another term of four years in his present position.

Benjamin G. Fernald, manager of the New York office of the Kerr Turbine Company, of Wellsville, N. Y., has been elected director and vice-president of the company.

E. P. Worden, formerly of the Fred M. Prescott Steam Pump Works, Milwaukee, Wis., has been appointed chief engineer of Henry R. Worthington & Co., Harrison, N. J.

J. H. Torney, assistant manager of the Southern Pacific Company's Atlantic Steamship Lines, has been appointed manager of R. Martens & Co., Inc., New York, one of the largest and most influential export and shipping firms in the world.

P. P. Bourne, formerly chief engineer of Blake & Knowles Steam Pump Works, East Cambridge, Mass., is again associated with the International Steam Pump Company, in connection with special engineering work at the company's office in New York.

Thomas Benson, of Baltimore, Md., formerly in charge of the floating equipment of the Pennsylvania Railroad at Baltimore, Md., has been elected president and general manager of the Standard Shipbuilding Company, New York. Wallace Downey, formerly general manager, has been appointed general superintendent.

OBITUARY

Wallace McDonald, manager of the McDonald shipyards at Mystic, Conn., died on March 15 from heart disease.

J. S. Raymond, vice-president of the Clyde and Mallory Steamship Lines, died recently at his home in Essex Falls, N. J., aged 46.

Fred T. Jane, well known as a writer on naval subjects and editor of Jane's "Fighting Ships," died suddenly at Southsea on March 8 at the age of 45.

John W. Hill, mechanical engineer and sales manager in charge of the Detroit office of the Bantam Anti-Friction Company, died very suddenly at his home in that city on February 12.

George McCrea Boyd, shipbuilder and for many years owner of shipyards in Shanghai, China, and at Nagasaki, Japan, died on February 11 at his home in Bayonne, N. J., in his eighty-sixth year.

Captain Mark S. Kirby, commander of the freight steamship *Francis Hyde*, running from New York to New Orleans, died from heart disease on February 18 at his home in Brooklyn, aged 73 years.

William Alfred Percy, an engineer and manufacturer, and formerly member of the firm of Henry R. Worthington & Co., steam pump manufacturers, died on February 16 at his home in New York at the age of 81.

SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

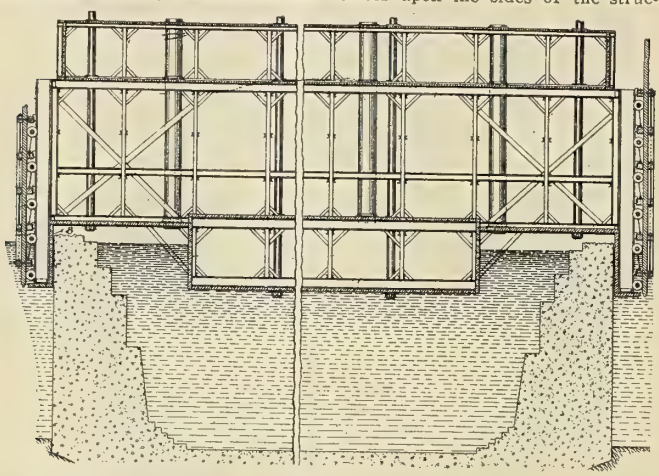
American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,146,958. BREAKWATER SHIELD FOR SUBMARINE BOATS. RICHARD H. M. ROBINSON, OF BRIDGEPORT, CONN., ASSIGNOR TO THE LAKE TORPEDO BOAT COMPANY OF MAINE, OF BRIDGEPORT, CONN., A CORPORATION OF MAINE.

Claim 1.—In a submarine or submersible boat, having a superstructure built thereon the deck of which is provided with a slot, a breakwater shield adapted to be elvated through said slot above the deck of the superstructure, and means for holding said shield in elevated position. 10 claims.

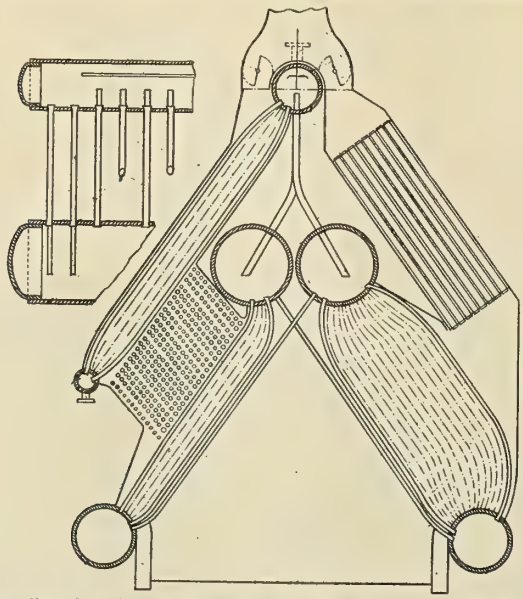
1,160,180. APPARATUS FOR CONSTRUCTING DRY-DOCKS. DUNCAN D. McBEAN, OF NEW YORK, N. Y.

Claim 1.—A structure for use in building dry-docks and like purposes consisting of a water-tight compartment capable of floating the structure and all its appurtenances, air-tight chambers along its sides open at the bottom in which the side walls may be built up from the foundation when the structure is sunk to the bottom, water compartments for loading the structure, and anti-friction devices upon the sides of the structure for running over the face of surrounding sheeting when the structure is raised or lowered. Seven claims.



1,168,748. WATERTUBE BOILER. WILHELM SCHMIDT, OF WILHELMSHÖHE, NEAR CASSEL, GERMANY, ASSIGNOR TO SCHMIDT'SCHE HEISSDAMPF-GESELLSCHAFT M. B. H., OF CASSEL-WILHELMSHÖHE, GERMANY, A CORPORATION OF GERMANY.

Claim.—In a watertube boiler, in combination with a pair of lower drums and an upper drum, two sets of watertubes connecting the lower drums with the upper drum, one set being smaller than the other set, a flue laterally of each set of watertubes, a feed-water heater in the flue adjacent to the smaller set of tubes, a steam superheater between the feed-water heater and the smaller set of tubes and in the same flue, and an air heater in the flue adjacent to the larger set of tubes.



1,170,529. SUBMARINE BOAT. HUGO GRIESHABER, OF NEW LONDON, CONN., ASSIGNOR TO ELECTRIC BOAT COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

Claim 1.—A submarine boat having a strong inner hull, a relatively weak outer hull, means for admitting water to the space between the hulls, means for admitting air to the space between the hulls to expel the water therefrom, and means for automatically regulating the pressure of the air admitted to the space between the hulls with reference to the pressure of the water surrounding the boat. Eight claims.

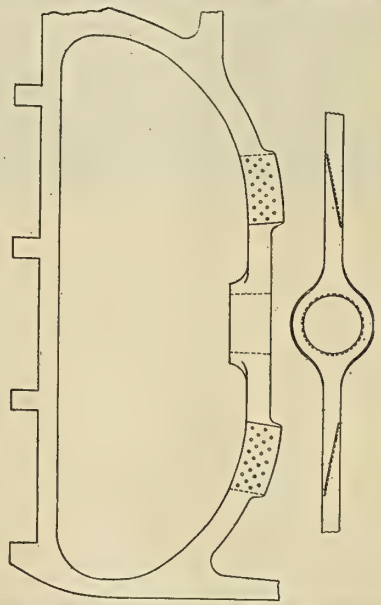
British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn place, W. C., London.

22,734 OF 1914. APPLICATION OF PLASTIC COVERINGS TO METAL PLATES, SUCH AS SHIPS' DECKS. WAILES, DOVE & CO., LTD., 5, ST. NICHOLAS BUILDINGS, ST. NICHOLAS STREET, NEWCASTLE-ON-TYNE, AND C. MACDONALD.

An improved construction of flooring for the parts of ships' decks and like surfaces not exposed to weather, without the use of expanded metal embedded in the structure, which consists in coating the metal surface with a bituminous solution, securing a layer of bituminous enamel upon said coating, moulding the plastic covering upon it in sections separated one from another by open channels, and subsequently entirely filling the said channels with bituminous enamel or other elastic material for the purpose of preventing the rising or buckling of the rigid flooring.

24,118 OF 1914. CONSTRUCTION OF SHIP STERN FRAMES. J. S. TOMPKINSON, 29, QUEEN'S TERRACE, NEWCASTLE-ON-TYNE.

A stern frame for ships, wherein the boss for propeller tail shaft is constructed separately and is provided with diametrically opposite projections by which it is joined to upper and lower parts of a discontinuous fore member of the frame characterized by the member comprising the boss and its projections being constructed of ingot steel pressed to shape under a hydraulic press and connected to the fore member by welding or by scarf joints.



19,386/14. AN AUTOMATIC DEVICE FOR RECORDING ORDERS GIVEN ON SHIPBOARD FROM THE BRIDGE TO THE ENGINE ROOM. E. HARIAT, F 70 BOULEVARD CHAVE, MARSEILLES, IN THE REPUBLIC OF FRANCE.

The invention relates to arrangements whereby all orders which are sent from the bridge of a ship to the engine room are recorded by employing the device at present employed for transmitting orders. Previously when this has been done by means of electrical circuits it has been necessary to have current flowing all the time the apparatus is in use.

23,340/14. IMPROVEMENTS IN OR RELATING TO THE DECKS OF SHIPS SO AS TO RENDER THEM APPLICABLE FOR USE AS LIFE-SAVING RAFTS. T. H. SCRIMSHAW, G. G. H. SCRIMSHAW, BOTH OF MEADOW LANE, LEEDS, YORKSHIRE, AND W. G. DAVIS, OF 215 BEESTON ROAD, LEEDS, YORKSHIRE.

The promenande or other decks of the vessel, and also the roofs of the deck houses or cabins are arranged to be divided into one or more parts and to be combined with lever apparatus whereby in case of collision or other emergency one or more portions of such decks or roofs can be converted into and used as a life-saving raft for rescuing the passengers and crew and for keeping them afloat until assistance is to hand. The platform or main portion of the raft is in square or rectangular form, and it is composed and constructed of the deck boards or the boards forming the roof of the deck cabins or deck houses.

4,701/15. AN IMPROVED COMPOSITION FOR COVERING THE OUTER SURFACE OF INSULATING MATERIAL FOR SHIPS' GALLEYS, BULKHEADS, AND THE LIKE. G. LIZIERI, OF 5, MILDMAY ROAD, NEWCASTLE-ON-TYNE.

The materials used in the composition are "isinglass soap," known as such in the trade, and which is a mixture of isinglass and dry soap, and is often used as a base on which to lay gold leaf or as a kind of size and white calcined magnesite in the approximate proportions of isinglass soap, 10 parts, and magnesite, 3 parts. The soap is dissolved in mythelated spirits of wine, and the magnesite added, and the whole thoroughly mixed together to a putty-like consistency. The outer surface of the insulating material may be roughened, but is usually covered with expanded metal or other open work to hold the insulation in place, and thus forms a key for the surface-finishing composition described above. The composition is applied in a thin layer, with a trowel or other tool, and can be moulded to any shape. When dry it is very hard, smooth and damp-proof, and does not expand or contract. It can be made in any color.

INTERNATIONAL

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Change of Address

ON May 1 the offices of the Aldrich Publishing Company, publishers of MARINE ENGINEERING and THE BOILER MAKER, were moved from 17 Battery Place to the new Printing Crafts Building, 461 Eighth avenue, New York city. Hereafter all communications to the American office of MARINE ENGINEERING should be directed to the new address.

The Printing Crafts Building, which is to be the future home of MARINE ENGINEERING, is a new twenty-two story structure especially designed to meet the needs of the printing and publishing trades. It occupies the block between Thirty-third and Thirty-fourth streets, facing Eighth avenue, adjacent to the Pennsylvania Railroad Terminal and directly across the street from the main New York Post Office. Every facility for the prompt and rapid execution of printing and publishing contracts has been incorporated in the new building and a cordial invitation is extended to all of our patrons to visit and inspect our new quarters.

Analyzing a Marine Steam Plant

NOT every marine engine is properly designed or properly adjusted, nor is every marine engine supplied with steam at the most suitable pressure for its economical operation. Again, it will be found that many marine engines are driving poorly designed propellers. In fact, all the way from coal bunkers to the propeller there are innumerable opportunities for losses in economy in generating and transmitting power, which may have been caused by poor design, faulty construction or the lack of necessary auxiliary apparatus. Such conditions must be faced by marine engineers, who are in no way responsible for them, but who must be able to find out why the owner of the vessel is not getting a reasonable return in power from the coal he is supplying for the operation of the vessel.

To determine the exact cause of the loss of the economy in a marine steam plant requires a careful analysis of the plant as a whole. That this task is not beyond the reach of the average engineer is shown by the instructive letters which are being contributed to this magazine each month by practical engineers who have faced and solved such problems. These letters tell how to combine indicator cards, and how to study the combined diagrams, comparing the theoretical curves with the results actually obtained. Methods of checking up the various credits and debits of heat in a marine plant are explained in simple language without the use of higher mathematics. It is not uncommon to find from such an analysis that the steam pressure, expansion ratio and condenser are utterly out of harmony. With such an analysis, however, if carefully and intelligently made, it should be possible for a competent engineer to locate definitely any trouble which hitherto may have appeared to be mysterious.

The ability of an engineer who is placed in charge of the engine room of a steam vessel, whether it be a tug boat or an ocean liner, to size up the imperfections in the steam plant and determine the possibilities of improvements which will result in actual savings in fuel consumption and reductions in the cost of operation of the vessel, will have an important bearing upon the future relationship between the engineer and his employer and upon the advancement and promotion of the engineer. Such ability is not an inborn characteristic of an engineer, but it is gained by experience and study, and to those who are ambitious to improve their standing and become masters of their profession we recommend a careful study and investigation of this important subject in all its phases.

Training of Officers for the Merchant Marine

TO provide facilities for educating and training young men to become deck and engineer officers in the American merchant marine a bill has been introduced in Congress authorizing the establishment and maintenance of two training schools, one on the Atlantic coast and one on the Pacific coast, for marine cadets. According to the provisions of the bill young men who have had at least six months' training as naval apprentice seamen or two years at sea in the merchant marine will be eligible as candidates for appointment as marine cadets. Appointments will be made in the order of merit as shown by a competitive examination, and they will be made only on condition that the applicant will obligate himself to serve on vessels of the merchant marine or army transport service or in the naval auxiliary for five years subsequent to the date of his graduation, and also that he will enlist in the naval reserve forces of the United States for two successive periods of four years each. The number of cadets appointed each year is limited at first to one hundred and twenty-five, of whom fifty shall have served as apprentice seamen in the navy. The course of instruction and training proposed is to continue for a period of two years and upon completion of the prescribed course the cadet will be entitled to receive the lowest grade of license required by law on ocean-going steamers for deck or engineering duties, as the case may be. It is proposed that the schools shall be conducted by the Coast Guard Service on vessels furnished by the Secretary of the Navy, and that each cadet shall receive an annual allowance of $500 (£103).

The lack of facilities for training officers for the merchant marine is apparent when it is remembered that only two states in the country maintain schoolships for this purpose. Competent officers for the rapidly increasing merchant marine must be provided and the benefits of-

fered by this bill should appeal to every patriotic American.

The two States which maintain schoolships are New York and Massachusetts. Prior to 1913 the New York schoolship was directed by the Board of Education of the city of New York, but since that date it has been under the jurisdiction of the State, and men are admitted to the school from the Great Lakes region as well as from the Atlantic coast. These facilities, however, are far too limited to meet the needs of the rapidly growing merchant marine, and national schools adequately equipped under the direction of the Coast Guard Service or Navy Department should be provided for both the Atlantic and Pacific coasts.

Profits from Old Vessels

BY M. WOOLLEY

A veteran master mariner who has sailed the seven seas had this to say one day before the European war began:

"American clipper ships used to pay for themselves in a single voyage when the American merchant marine was in its glory. My own clipper, which cost a small fortune, repaid her cost to her owners in a single trip to the Philippines. That time will never be seen again. It is gone forever!"

But how mistaken was this sorrowful old salt, now relegated to retirement ashore. Blockades and submarine campaigns and the demands of war have made the world short of ships. Ghouls have gone into ship cemeteries and exhumed the remains of many an old "tea-kettle" and many an old sailing vessel to get the world's goods going again. Exhuming marine mummies is now the sport of shipping firms, and superannuated ships are worth not only twice what they originally cost, but they likewise will repay for themselves on almost every trip for some time to come.

We Americans, regardless of what legislation in the immediate future is likely to bring us, are about to find ourselves equipped with a merchant marine almost over night. We are not waiting for them to be built. We are digging up dead ships and sending their ghosts flitting across seas, taking coasters off their shore-line routes and sending them broadcast, and taking unprofitable bottoms out of pawn to put them in a service where carriage prices are bound to bring a return worth while.

Within one week this spring nearly a score of coast steamers were taken off their routes on the Pacific and placed in the overseas trade with China and Japan. These boats all go loaded to the superstructure. Charter parties, still soaring, have reached unprecedented figures. Prices are responsible for this remarkable transition. Any craft which is sufficiently seaworthy to pass the inspectors gets a new lease of life, and possibly the inspectors wink at many a slight defect.

Especially is this an era when the decaying windjammer returns to power. The kings of old are returning to their thrones and claiming their crowns as common carriers. Sailing ships which have been lying in boneyards for years and which it was once believed would never again feel the heave of the open sea, have been rejuvenated and returned to a road on the trackless ocean.

Many steamers have likewise entered on new and extended careers. For instance, the *City of Pueblo,* which for years has done nothing but coast between Pacific ports, is now in the Far East trade. Her first voyage to Hong Kong, Kobe and Yokohama netted the owners a handsome profit, probably nearly as much as the steamer is worth. Many of this old-time ship's colleagues have also taken to deep water in their old age, so that now they pass one another in mid-Pacific instead of off shore from Oregon, Washington or California.

Ships which have never felt the fury of a typhoon or the seductiveness of a trade wind, and which have never ventured so far from home as to cross an ocean, are now plowing their way back and forth between China and Japan and the United States. What we want to do is to get these makeshift carriers started into the South American trade until we can get a host of new ships, operating under favorable laws, into the field.

At the fabulous rate of $20,000 (£4,100) per month, the American steamer *Edna* has been fixed on time charter for a year in the Atlantic coast trade. Just listen to this: The charter will bring this ship's owners the princely sum of $240,000 (£49,200). This amount will build a dream of a freighter, and probably two ships like the *Edna.* Likewise some old ships are being sold for sums far and away more than they cost. An American ship was sold the other day to the Japanese for $1,000,000 (£205,000), and new it probably cost less than half that sum.

Here is another startling instance of the value of old and decrepit sea craft, one which should make us all wish we had an old tub of some sort peacefully reposing in the backyard, but not too far away from the lashing waves: The steamer *Dunholme* has been sold to an oil company to help relieve transatlantic traffic, for $850,000 (£174,000), or nearly one million dollars. Four years ago the hulk of the *Dunholme* was sold, according to report, for $30,000 (£6,150), after a fire, which burned away only her superstructure and interior fittings. The *Dunholme* is capable of carrying but 5,500 tons.

If the demands keep growing it will soon pay the owners of small fishing smacks, and even motor boats, to charter for deep-sea service. Pacific coast purchasers of Great Lake steamers to be brought west via the canal or the Horn were recently offered attractive charter rates. One purchaser was offered $240,000 (£49,200) per year for his two boats, making a total of $480,000 (£98,400). But he figured he could do better himself on the Pacific. Others similarly situated were offered charters equally as attractive, but in almost every instance declined them.

The ships purchased on the Great Lakes were for the Alaskan service, mostly between Seattle and Alaskan way ports. This field or route now has the largest fleet of coast steamers in service anywhere in America, and it is constantly growing. As many of these ships are, however, suitable for ocean-going trade, they may be withdrawn for a time and sent into the deep-sea trade. Our next biggest lot of American bottoms is in the fruit trade. Banana trade with the Central and South American countries engages more American steamers flying our own flag than any other shipping business having a foreign end. This, with the Great Lakes traffic, is about the biggest lot of ships we have engaged in marine movements anywhere.

Oriental commerce is growing by millions. It is climbing up by leaps and bounds. The prognostication of statesmen that the Pacific is "the eye of the world" is proving true. The January carrying business between Seattle and Far Eastern ports was the greatest by far on record. There are five miles of switches at Seattle laden with cars of freight awaiting steamers to cross the Pacific. It has been necessary to empty the contents of many cars alongside the tracks so that Eastern rail shipments may not be congested for want of cars.

A Japanese firm recently bought the American steamer *Mackinaw,* paying three times as much as was paid for her when bought by Americans eight months ago. To be exact, the Japanese paid $300,000 (£61,500), while the

American owners paid but $100,000 (£20,500). A fleet of four old schooners, considered junk not many moons since, were recently sold for a total of $104,000 (£21,300).

The Philippine Islands fear a withdrawal of their own inter-island steamers for use elsewhere throughout the world. Already Philippine industry has been hurt by the loss of several Chinese ships withdrawn for over-ocean carrying. Philippine inter-island ships have made several trips to the United States for the first time probably in history, and matters are so serious in business circles in Manila that the Government has ordered the army transports to carry freight to and from the islands.

Calls for sales or charters of ships are coming into the shipping offices of the Pacific by telephone, telegraph and by mail. Shipping offices everywhere are taking on activities similar to those in rich mining camps.

But, let us hope that superannuated steamers and rejuvenated ships will save the day for us until we can replace them with the best and biggest ships in the world.

Freight Handling at Marine Terminals

BY A. JACKSON MARSHALL*

The costly congestion of freight at railroad and steamship terminals has reached such proportions that before long remedies will of necessity have to be evolved. A study of the problem would indicate that railroads and steamships are carrying freight most efficiently between points, but the handling of merchandise to and from and in the terminals leaves much to be desired.

It therefore appears that changes will have to be effected in the transportation of freight to and from the terminals and in the handling of merchandise in the terminals themselves. While great improvements have been made, much more could be effected in these two phases of local freight handling. It seems to the writer that the full measure of possible success can only be obtained when the local transportation and the handling of freight in the terminals are considered jointly, instead of as two separate and distinct phases. No matter how perfectly developed the method of freight handling in terminals may be, the highest efficiency cannot be obtained unless the movement of freight to and from terminals by trucks be such as will exactly fit into the scheme of terminal operation and vice versa.

It is apparent that the local transportation of freight is unsystematic and very costly. It is hardly necessary to review the chaotic conditions existing in this branch of the work, which seem to get worse instead of better. Almost everyone is familiar with the losses resulting from the influx and outflow of freight during certain hours of the day at the terminals and the inactivity at other periods, due to the fact that nearly everyone wants service at the same time, which is a physical impossibility to render. The thousands of trucks compelled to wait their turn pile up a loss that is counted in the tens of millions.

If each truck had a definite time to call for or deliver merchandise to the terminals and the schedules were observed, the terminals, perhaps, operating at night as well as day, delays and losses due to congestion would be reduced to a minimum. Furthermore, trucks and trailers could systematically operate better at night, since they would not be compelled to constantly buck street traffic, with attending delays and accidents. Sooner or later the growing traffic of our cities will force the use of streets at night. There is hardly more reason why the streets of our cities should not be used at night, especially for the transportation of freight, than there would be to confine the use of railroad tracks to day traffic.

If the existing trucking individuals and concerns could get together and work out a method of systematically cooperating in the development of a scientific schedule of operation much could be accomplished. Otherwise, it appears that the railroads must either go into the delivery of freight direct from shipper to consignee, or that large and efficient local transportation companies will have to be formed to sympathetically work with the railroads in the elimination of freight congestion with its attending losses. No matter what method or methods may be employed, action, and prompt action, is imperative.

The more thought the writer gives to the subject the more it appears that organizations possessing the qualifications of efficient express companies would prove to be the solution, for such organizations would have an intimate and practical knowledge of railroading, would understand the receipt and dispatch of merchandise through terminals, have national and international organizations and the connections necessary to the forwarding of freight, and know the local transportation phase of the work. Furthermore, such a development would not be in the nature of an entirely untried experiment, for the transference of express is not so unlike the handling of freight, except that the latter is somewhat more bulky and usually does not move so rapidly. But it is the writer's personal opinion that the costly congestion of freight could be materially eliminated, and far-reaching economies effected if organizations similar to express companies would go into the business of express freight, possibly operating their own terminals and fleets of motor trucks for local transportation, operating along the same general lines employed in the handling of express.

The idea of national organizations competent to handle the freight business much on the same basis as express has been handled seems to be such a simple solution of the problem that the writer has hesitated heretofore to give public expression to it, fearing that it possessed a weak spot unknown to him which possibly prevented others better informed from having expressed the thought before. However, the idea is advanced for whatever value it may have, and if it is not feasible the fact will shortly be known. The details incident to such a development could be worked out if the main thought is acceptable.

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Corresponding Conditions of Steamhip Service

BY ARTHUR R. LIDDELL

Suitability of sizes and speeds of vessels for particular services is a very relative conception, and developments in various directions may entirely alter the circumstances of any given case. But an existing general scheme of dimensions and speeds corresponding with shorter and longer voyages can readily be adapted to new departures of different kinds, and will always serve as a model for tables intended to meet special conditions.

A ship of, say, 100 feet in length, 20 feet in breadth, and 10 feet minimum sea draft, may be assumed to be suitable for voyages of a certain distance when steaming at a speed 6½ knots, and thereby to burn a certain weight of coal and carry a certain deadweight of cargo. What are the corresponding conditions for a vessel of, say, four times or any other multiple of her length?

In general this will depend on the following considerations: The corresponding lengths of voyage for two vessels under comparison will be somewhat in proportion to

the lengths of these. There is a general tendency for the breadths and ballast drafts of vessels to vary as the square roots of the lengths, so that the displacements vary as the squares and the areas of wetted surface as the 1.5th powers of the lengths. This depends on the not yet accepted principles of wave formation, relation of wave length to wave height, etc. Meanwhile the wave height may, for practical purposes, be taken to vary as the square root of the wave length. The speeds of vessels of a given class—say of cargo carriers—tend to vary as the square roots of the lengths, and therefore the horspowers might be expected to vary as $L^{1.5} \times V^3$, where L represents the length of the vessel in feet and V her speed in knots, or, since V varies as $\sqrt{L}$, as L^3. In reality, however, increase of draft gives better propulsion, and the horsepower varies more nearly as $L^{2.5}$. The bunker coal required for the corresponding voyages may vary as $L \times I.H.P. \div V$, or as L^3, the weight of cargo, machinery, and coal as the displacement; i. e., as L^2, and the time spent on the voyage as $L \div \sqrt{L}$, or as $\sqrt{L}$.

To avoid side issues, the proportion borne by weight of machinery to indicated horsepower and the weight of coal burned per indicated horsepower per hour are taken as constant, and the resistance is assumed to depend only on the area of the wetted surface and the speed. Further, the fineness of ends of the vessels are taken to be similar, as are also the types of the vessels and the proportionate lengths of deck erections, while the retardation of speed on account of bad weather is taken to be the same in degree in all cases. Breadth, depth and draft are taken as bearing the ordinary proportions to the length for the different sizes. Table A shows the lines along which the different conditions relating to vessels and their voyages tend to develop, with alterations of size, and the powers of the length L, with which the different positions vary. The system may be applied to the expansion of a vessel, the particulars of which are known, in the following manner:

In the first place the actual data of the model vessel must be used as a basis instead of those in the table. For the not very great variations in size that will usually come in question, a variation of the different positions in relation to the powers of L that govern them (see lower line of Table A) will give sufficiently correct results, provided breadth and draft be each made to vary with $\sqrt{L}$ and the freeboards be those laid down by the International Commission or be in proportion to them. For designing purposes, the conditions must be given or must be worked out for a vessel of approximately the length desired. If carrying capacity or speed be insufficient or too great, the various proportions must be increased or diminished according to the powers of the length L, given at the foot of Table A.

It will be observed that the powers of the dimensions with which the values in the table are made to vary are not in all cases those commonly employed. The reason of this is that breadth and draft tend to vary, not with the length, but with its square root. When a vessel is to be propelled at a higher speed than a standard one of the same dimensions, the ordinary rules of comparison should be applied in making the necessary alterations. Thus, for relatively higher or lower speeds for a given length, the indicated horsepower must be varied in the first place in proportion to the cube of the speed in knots, and in the second with due regard to the number of speed-wave lengths in the length of the vessel; i. e., to the favorable or unfavorable positions of the humps on the speed-power curve. For variations in the proportion borne by length to $(\text{knots})^2$, the variations in the indicated horsepower required for given speeds depend on too many factors to admit of their being taken into account by a simple formula. For faster vessels than cargo boats, proportions borne by length to $(\text{knots})^2$ of 1 : 0.7, 1 : 1.27, and 1 : 1.83, respectively, have been stated on good authority to be favorable to speed, while those of 1 : 0.42, 1 : 0.98, and 1 : 1.55 were stated to be unfavorable.

For cargo vessels of average fullness of ends, the row of favorable proportions may perhaps be extended by 1 : 2.39 and 1 : 2.95, and that of unfavorable ones by 1 : 2.11 and 1 : 2.67.

Though the advantages and disadvantages as regards propulsive efficiency are not so great in these relatively slower vessels, instances have been known in which lengthened vessels have steamed at their former speeds with considerably less horsepower. If speed be the basis of a new

TABLE A.—SHOWING CORRESPONDING CONDITIONS OF STEAMSHIP SERVICES FOR VARIATIONS IN LENGTH OF VESSEL

Dimensions of Vessel.										
Length (L) Feet.	Breadth Feet.	Ballast Draft, Feet.	$\sqrt{\text{Length.}}$	Speed.	Distance Run.	Coal Required.	Indicated Horse-power.	Weight of Machinery Cargo and Coal.	Duration of Voyage.	Displace-ment.
Feet.	Feet.	Feet.		Knots.	Knots.	Tons.		Tons.	Days.	Tons.
100	20	10	10	6½	500	12	150	200	3.2	600
225	30	15	15	9¾	1,125	137	1,150	1,010	4.8	3,037
400	40	20	20	13	2,000	768	4,800	3,200	6.4	9,600
625	50	25	25	16¼	3,125	2,930	14,650	7,810	8.0	23,437
(900)	(60)	(30)	(30)	(19½)	(4,500)	(8,748)	(36,450)	(16,200)	(9.6)	(48,600)
			Powers of $\sqrt{L}$	L with which the values in the different columns vary.						
				$\sqrt{L}$	L	L^3	$L^{2.5}$	L^2	$\sqrt{L}$	L^2

TABLE B.—SHOWING PROPORTIONATE WEIGHTS OF MACHINERY, COAL, AND CARGO FOR VARIATIONS IN LENGTH OF VESSEL

Length.	Displacement.	Weight of				
		Machinery, Coal, and Cargo.	Machinery.	Coal.	Machinery and Coal.	Cargo, Exclusive of Coal.
Feet.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
100	600	400	30	12	42	558
225	3,037	2,024	230	137	367	2,670
400	9,600	6,400	960	768	1,728	7,872
625	23,437	15,625	2,930	2,930	5,860	17,577
(900)	(48,600)	(32,004)	(7,290)	(8,748)	(16,038)	(32,562)

design, it may be of advantage to choose a length that will give favorable conditions. For existing vessels there may be speeds, less than the extreme ones, at which propulsion is more economical. That deep immersion is conducive to good propulsive effect is well known. The ballast or minimum sea draft of a steamer is commonly about equal to the square root of her length. This is a fairly good standard of comparison, whether or no a little more or a little less draft be considered suitable.

Tables A and B contain approximate values that are not to be taken literally. The tables may be enlarged by interpolation to any desired extent, and for application to given conditions it will be advisable to vary the figures in accordance with data obtained from vessels on the services in question. As they are, they give general indication of the changes which accompany increase of size and of distance run.

Inclining Experiments—Practical Hints

BY L. A. BAIER, B. SC.*

Almost all works on theoretical naval architecture devote some space to a description of the inclining experiment carried out on many vessels to determine the metacentric height, known as GM; or what it really amounts to, the vertical position of the center of gravity of the ship in various definite conditions. However, all such articles coming under the writer's attention have been confined to a discussion of the theory involved, with only a brief outline of the actual experiment itself. It is the intention of this article, therefore, to omit any detailed review of the familiar theory involved and to describe the practical methods of carrying out this experiment. Now

$$GM = \frac{w \times d}{\Delta \times \tan \Theta},$$

where GM = required metacentric height in feet,
w = weight in long tons required to list the vessel through an angle of Θ degrees,
d = distance in feet through which w is moved in order to produce a list of Θ degrees,
Δ = total displacement of vessel in long tons at the time of the experiment.

It can be readily seen, then, that in order to obtain the GM of a vessel we shall have to place a certain weight on board, move that weight through a measured horizontal distance, and determine the angle of list produced. This list may be either longitudinal or transverse. With the exception of submarines, vessels are only inclined transversely, and that is the phase we will keep in mind in the following description. We will now take up the successive steps to be followed both in the preparations and in the experiment itself.

Preparations

The first essential is to determine approximately the amount of weight that will be required, or the value of w in the formula. This weight is made up usually of pigs of iron running from 50 to 125 pounds per pig.

From the previous equation we find that

$$w = \frac{GM \times \Delta \times \tan \Theta}{d}.$$

We can determine very closely about what Δ, the displacement, will be at the time set for the experiment, by reading the present drafts of the vessel, referring to the displacement curve and correcting for any future additions or subtractions of weights.

The value of Θ is usually taken at from 2½ to 3 degrees. d, the distance through which the weight is to be moved, is determined by the available beam of the vessel. This distance should be kept as large as possible, as the greater length of d we can use the less weight is required for the same list.

The remaining factor in this preliminary estimate of w is GM, which may be taken at about the value expected as calculated from the estimated heights of the centers of gravity and from other design data. This is the factor which may lead us astray in our estimate, especially in the case of old vessels where we have no definite data, and in the case of vessels in an uncompleted state. We shall shortly show how to check this factor when loading the pig on board ships.

The following data are taken from an experiment recently carried out by the writer on a United States naval vessel under construction at the Seattle Construction & Dry Dock Company's plant at Seattle, Wash.

In this case

$$\Theta = 2\tfrac{1}{2} \text{ degrees and } \tan \Theta = 0.043661.$$

The beam of the vessel was 45 feet 6 inches, giving an available travel athwartship of about 40 feet. The GM expected was about 30 inches, or 2.5 feet. The displacement, after all allowances were made, was estimated to be 2,250 tons. Then

$$w = \frac{2.5 \times 2{,}250 \times 0.043661}{40} = 6.15 \text{ tons.}$$

The customary, and really only accurate, method is to start the experiment with the vessel upright. Therefore we shall need 12.3 tons altogether—6.15 tons on each side. An order is now issued to the foundry or storekeeper to weigh up and deliver alongside the vessel on the day previous to the date set for the experiment this amount of pig. Each pig should have its weight plainly marked on in with white paint and the total load should be delivered, when possible, on a small hand car, to facilitate the crane loading it on board ship.

Preparing the Vessel

The next step is to prepare the vessel. The exact location of the weights on the ship depends, of course, on the type of vessel and deck arrangements. Rough cribs should always be used to contain the pigs, as the centers of gravity of the weights are then easily determined and can be kept in certain positions, and the decks, bulwarks, sides of deck houses, etc., are protected.

These cribs are made of rough two-by-fours and should be divided into two separate compartments. In the case of a tug, for example, two of these double cribs would be made of such dimensions as to allow placing on deck amidships between the bulwarks and deck houses, one to port and the other to starboard. The volume needed in a crib for pig iron runs about 250 to 300 pounds per cubic foot. Note should be taken of the average lengths of the pigs and the cribs dimensioned, to insure the most compact loading. The cribs should be placed, in the case of a tug, amidships opposite or near to a thwartship passageway, so that the pig can be easily carried from one side to the other.

Arrangement of Cribs

The following description of the arrangement of the cribs on the United States vessel referred to above may prove of value, as this method, when applicable, effects a great saving in time and in the number of men necessary for the experiment.

The vessel was so arranged that there was a clear passageway through the middle deck house, with doorways about 9 feet wide on either side. Two double cribs 8 feet

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by 3 feet by 2 feet were placed on deck opposite these doors, one to port and the other to starboard. A temporary track was then built across the ship from crib to crib and blocked up level so as to clear the door sill or coaming plate. A small, flat car was roughly built to fit this track, for the purpose of carrying the pigs from one crib to the other when required. After the pig was transferred the car was always placed on the centerline of the vessel while the readings were being taken. By this means only four men were required to move the weights.

On this vessel two angles of heel were required, so a similar arrangement of cribs and track was constructed on the second deck directly under those on the main deck. These cribs, cars and track should, of course, be saved, and can be used in a large number of cases and the expense of carrying out an inclining experiment by this method will be found to be materially reduced.

"A Place for Everything and Everything in its Place"

The next step is to have the vessel cleaned up. All scaffolding and dunnage should be put ashore or piled up in such a manner and location that its weight and the position of its center of gravity can be easily determined. Port lights and all doors should be closed. All lockers or movable furniture, etc., should be located in their proper positions. Hold battens should be in place, tool boxes and benches put ashore, and every effort made to get off the vessel all possible articles not permanently belonging there and to have all equipment, etc., on board in its proper location.

A careful inspection of all tanks should be made. If the vessel has a list or excessive trim, the proper tanks must be *filled* to correct this. Care should be taken that all tanks, boilers, double bottoms, etc., are either completely filled or entirely empty, to eliminate any free water or oil surfaces.

The ideal case of no free liquid surface cannot always be reached, but this is the result to strive for. The following point is often overlooked in correcting the *GM* obtained from the experiment for free liquid surface. The metacentric height is reduced by $\frac{Pi}{V}$ and not by $\frac{i}{V}$, where

P = specific gravity of the liquid compared with that of the water in which the vessel is floating.

i = sum of all the moments of inertia of the free liquid surfaces in feet and about their own longitudinal neutral axis. Where there are no longitudinal watertight bulkheads this practically coincides with the longitudinal centerline of the ship.

V = total volume of displacement of the vessel in cubic feet.

Just previous to the experiment all air hose lines and steam or water connections should be put ashore.

Location of the Plumb Bobs

The location of the plumb bobs should next be arranged for. These plumbs consist of a four- or five-pound weight attached to the end of a length of fine steel wire, and hung at the other end in such a manner as to allow free swinging of the weight athwartships.

Two rigs are generally used, one forward and the other aft. On small vessels these plumb bobs are usually hung from a light support 10 or 12 feet high erected on the deck at the centerline. The weight should be allowed to hang in a bucket of oil as a damper. Water is sometimes used, but has not very much effect in reducing the vibration of the bob.

The most convenient way of measuring the swing of the wire is to construct a small flat scale, say 24 to 30 inches long, laid off in inches and tenths both ways from a center mark 0. When ready to begin the experiment, all men on board take their proper locations marked on the centerline with chalk. The scale is then clamped to the plumb bob support just above the pail of oil and adjusted so that the wire just hangs over the 0 mark, and so that it is perpendicular to the wire. Then all readings of the swing of the wire either to port or starboard can be read off directly.

In large vessels the plumbs can usually be hung through hatches and the scale clamped to a small support located in the hold. The length of bob should be as great as convenient. The tangent of the angle through which the vessel lists is then the reading of the scale in inches divided by the length of the wire in inches from the point of support to the scale.

The centerline of the vessel in the vicinity of the cribs, and the location of the midship section or the heel of a known frame near the midship section, should be center-punched and chalk-lined in before the experiment is started. The positions of the centers of gravity of the cribs, track, car, observers, etc., can then be located from these marks for future reference in working up the results.

We are now ready to begin loading the weights on board. Knowing the tangent of the angle of heel desired and the length of the plumb wire, we can compute approximately what the reading of the scale should be. Before loading the pig iron on board, the scale should be temporarily clamped at 0. A man with a comptometer can then keep tally of the amount of weight carried on board.

The first load, say 6.15 tons, should be placed in one compartment of the double crib nearest the dock. The comptometer will show the total weight on board at all times, and by noting whether the swing of the bob reaches the reading expected a check can thus be had of the actual amount of the pig required. An overestimate of the *GM* expected would now be shown up by the bob falling short of the required reading, and vice versa.

Additional pig iron can now be put on board or taken off, as is required to list the vessel to approximately the angle required. If, for example, the forward compartment of the port crib has been filled first with the 6.15 tons, then the after compartment of the starboard crib should be filled with the other 6.15 tons to balance the effect on trim.

Precautions in Mooring the Vessel

Just prior to the experiment the vessel should be moored head or stern into the wind by a single line fore and aft and kept entirely free from the dock or any floats, etc. Although there may not be enough wind at the beginning of an experiment to justify swinging a vessel, this factor should be carefully watched, as a slight breeze blowing against the masts and rigging will materially affect the readings at the scale. A skiff should be kept at hand for use in reading the drafts and taking the density and temperature of the water.

The men who are to assist in the experiment should be instructed beforehand as to their individual duties. As noted before, during each reading the men should always return to their assigned positions on the centerline, especially when on board small vessels.

Experience has shown that one of the big assets insuring the successful carrying out of any experiment is the preparation of blank forms for recording the observed data. Too much stress can not be laid on this point. In

preparing these blanks all the conditions liable to arise are more easily anticipated, and in the use of the forms a logical sequence and arrangement of facts are obtained, the data are much more clearly recorded, and there is not so great chance of neglecting to note all the facts or data required.

The Experiment Proper

A brief summary of the successive steps in carrying out the experiment will now be given:

1. A final survey of the vessel should be made to check the condition.

2. All the men required for the experiment should now be taken on board, the gangway removed and the vessel moored free, as described above.

3. By means of the skiff the drafts forward and aft can be taken and at the same time the temperature and density of the water can be observed. A hydrometer is generally used to measure the density of the water.

4. The vessel can now be heeled by transferring the pig from one crib across the ship to the empty compartment of the other crib. After heeling to one side the weight can be brought back and the 0 position of the bobs checked, and then the vessel heeled in the opposite direction.

5. Immediately after the experiment a record should be made of the condition of the vessel, noting the weight and position of the center of gravity of all the foreign weights on board and of the weights still to come on board to complete the vessel. The condition of all the tanks, boilers, condensers, etc., should be noted as to the amount of liquid contained and the extent of free surface, if any. The condition of the bunkers should be recorded.

The method of ascertaining the value of *GM* from the experiment and extending the results for various conditions of the vessel are, of course, familiar operations.

Aside from satisfying guarantees of certain values of *GM*, the results of an inclining experiment are of value to the builder for future designs, and every effort should be made to insure the experiment being carried out accurately and the results intelligently worked up.

Ocean Freighters*

BY ERNEST H. RIGGS †

Ocean freighters can be divided into two main divisions, cargo liners and tramps; the first division can be further divided into types such as oil carriers, bulk freighters, general freighters, refrigerator ships. Freight liners are subject to very much the same rules as passenger liners. Each service develops and improves its own type, whereas in tramps the tendency to standardization can be noted.

This standardization is natural when the circumstances are considered; the ships are to be generally useful, the larger the ship the more cheaply the freight is carried, but harbor depths, wharves, etc., in the smaller ports soon limit sizes, and thus we are forced to a compromise, which can be called a 7,000 ton deadweight carrier, 22 feet 6 inches draft, and of about 360 feet by 50 feet by 29 feet 6 inches molded dimensions.

Statistics give the following average dimensions for cargo vessels:

Item	Year 1890	Year 1900	Year 1910
Length in feet	285	312	340
Breadth in feet	37	41½	46
Draft in feet	19¼	20½	21½

The advance in dimensions is steady and without doubt will so continue; dredging operations continue the world over, and all harbor authorities are anxious to provide the best facilities. It is safe to say that the shipbuilder can easily keep pace with terminal improvements, and in many cases ships have been built with a margin of 2 to 3 feet in their loading ability, in order to be ready to take advantage of port improvements not completed at the time of building.

Single Deck Cargo Steamer.

Turning more particularly to types, one which has been developed to a great extent recently is the single deck cargo steamer. Pillars and hold beams are now eliminated entirely, if desired, from all cargo spaces; arches, transverse and longitudinal, carry the deck and tie the structure together. Single deckers up to 34 feet 6 inches molded depth are being built to receive the highest class. Needless to say, the side framing is getting up to 15-inch channels for such ships. Another comparatively modern idea is in constructing double bottoms with a solid plate floor on every third frame only except at the ends and under machinery.

The omission of all side stringers also should be noted, compensation for which is readily made. In vessels of great depth it is scarcely advisable to fit no stringers on account of the danger of the frames tripping, but the classification tabular number can well be reduced.

Joggling frames and beams are now very general; flush decks made by joggling down the beams and fitting joggled plating are much cheaper than flush decks with planed and fitted edge laps, equally efficient for trucking, and better from the riveting and structural point of view.

Twin masts and king posts are a modern development to be noted. Shorter booms and better working conditions generally result where they are adopted.

Wide spaced framing is adopted in many ships—i. e., the rule spacing laid down by the classification societies is frequently increased several inches. Frames and shell have to be strengthened, of course, and no saving in weight results, but the number of parts to be handled is materially reduced.

Wide spaced pillaring is, generally speaking, a modern development. Lloyd's first gave definite tables whereby the forest of small pillars could be replaced by more widely spaced and larger pillars, with girders under the decks to transmit the loads to these pillars. No weight saving is to be made, but greatly increased facilities for stowage results. Wide spaced pillars had been in vogue for some years before the classification printed rules gave tables for the same.

Topside tank ships have come to the front, and for vessels which have to make long oversea voyages in ballast, they, together with the usual double bottom, furnish a most excellent distribution of the ballest weight; particularly in bulk trade ships, where the space under the deck is apt to be left empty, the topside tank is well worth its cost. As a safety arrangement also they have points, the two sides, from the load waterline up, constituting a protection in the event of collision.

It is to be noted that the turret and trunk steamer have not lasted as general types; their construction takes place only very occasionally. The same may be said of whalebackers; though a Great Lake type, they are used on the ocean, but not to any great or growing extent.

There is one great advance to be noted in our period which is worthy of special mention, and that is the revival of the longitudinally framed ship, for which credit must be given to Mr. J. W. Isherwood. The adaptation of longitudinal construction to merchant steamers has been of singular advantage in several types, notably in oil

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* Abstract of paper presented at the International Engineering Congress, San Francisco, Cal., September, 1915.

† Naval Architect, New York Shipbuilding Company, Camden, N. J.

steamers. The system is ideal for oil steamers and all long and shallow types. For bulk and general freighters the advantage also is considerable, but is not so marked as for oil tankers. In all types there is an appreciable saving in weight. Costs usually compare favorably after the first ship at each yard has been built and experience gained. Torpedo-boat destroyers and light cruisers also can well be built on this system.

The advantages of the system are less structural weight, reduced vibration, greater longitudinal strength, and greater capacity in some instances; the disadvantages are transverses sticking out into holds, operative in some trades, and holding up coal or other bulk cargoes on the longitudinals. It is interesting to note that the total gross tonnage built and building to the system is nearly 1,500,000, which speaks for itself, as the period covered is under ten years.

The carriage of cooled and refrigerated cargoes has made considerable progress in the last ten years; fruit is carried by regular liners in vast quantities from the warmer to the colder climates, particularly bananas. The carrying of chilled and frozen meats has reached proportions undreamed of ten years ago, so much so that the carrying of live cattle has very largely ceased.

While it cannot be said that radio telegraphy has influenced cargo ship design, yet at the same time the installation of such apparatus is rapidly becoming universal, and indeed is now compulsory on all vessels carrying fifty or more persons; the greater ease of transmitting orders from agent or owner needs no comment.

The elimination of wood decks is noticeable; plain steel decks are the thing in freight spaces, and many substitutes for wood in living spaces are on the market.

Influence of the Panama Canal

The Panama Canal has already begun to influence ocean freighter design, and vessels for long voyages and of large dimensions are being constructed in more or less modest numbers. The American Hawaiian Steamship Company's vessels are probably the best type of large ocean carriers built for canal trade. The latest vessels of this fleet are worthy of a little study.

The ships are 430 feet by 53 feet 6 inches by 39 feet 6 inches to the shelter deck and carry 9,000 tons total deadweight on 28 feet draft. They have power for 12 knots at sea, and have limited passenger accommodations. They are fitted with all the decks their depth will allow, and are arranged for oil fuel, single screw drive.

Fast fruiters of large dimensions have also been the subject of numerous designs, their speed having been based on the average speed of freight across the continent. This will necessitate a sea speed in the neighborhood of 16 knots, which is quite practicable as far as the ship and machinery are concerned, and is, in fact, the general speed for a combined fruiter and passenger ship in the West Indian trade. It can be said that many designers are at work on ships for the canal trade, and that definite types will be evolved when conditions are more settled. Radical departures from standard types do not appear to be imminent; it is safe to say, however, that the ships will be both larger and faster than those in general use on either coast.

Large lumber steamers for canal trade are also under consideration. One design the writer has seen, prepared by Messrs. G. W. and J. S. Dickie, contemplates a vessel 440 feet long, 12 knots sea speed and 5,000,000 board feet of lumber; oil fuel and with ballasting arrangements such as will enable partial loads, including deck loads, to be safely carried, while collecting cargo from several points for the trip through the canal. A long trunk and elevated cargo handling gear are features of the design.

Terminal Facilities

The large amounts of money being spent on terminal facilities are bound to have an increasing effect on ship design. Take the Bush Terminal at New York as an instance. The writer calls several instances to mind where cargo ports had to be a fixed distance from the bows of a ship to suit openings in shed sides; it did not matter whether they came abreast the other breaks in the structure or not, a fine, new ship had to be butchered to suit some ramshackle old wharf that would not last five minutes in any fire that amounted to anything. These quaint old relics in the way of wharves are rapidly being replaced in all our big harbors. Wharves will, in future, be so arranged as to give reasonable latitude in ship arrangement. There mere fact that development is being allowed for will automatically take care of the ship's interest.

Rapidity of despatch becomes more important the larger the ship is; also, the larger the ship the more self-sustaining she becomes in the matter of minor repairs. It is a sign of the times to be noted that the ship's force are asked to do less and less while in port, at any rate among the large lines, so that they can have reasonable freedom in port and get home for just as long a time as under former conditions, with the longer wait in port. The gain due to a quick turn around each trip, might easily mean two or three voyages more per year.

The improvement in crew's quarters aboard ship has been noticeable of late years, and this is by no means confined to the ships of any one nation. This is one of the handicaps of American shipping that is being removed by the other fellow grading up, instead of ourselves grading down.

Lumber Steamers

Lumber steamers are in a class by themselves; they should be specially designed and proportioned for their trade, and when such is the case deck loads are by no means the menace they are in an ordinary steamer used to carry lumber cargo. Besides being of extra beam, the ship is built with a strengthened main deck and special bulwarks; these precautions, together with lashing chains, enable cargoes up to 14 feet high to be safely carried. Trouble is apt to arise when ordinary cargo steamers, designed for a hold cargo only, load lumber to their statutory (European) freeboard and carry a deck load to do it. The International Load Line Conference will have the question of the freeboard and deck loads of lumber steamers to consider. The technical press has lately contained considerable comment on this vexed subject. The fact that many lumber steamers are operated with oil fuel makes security of deck load doubly necessary. The solution is minute subdivision of oil tanks in both directions, so that it is not posssible to get large free surface losses in stability.

The deep centerline tank adopted by Mr. E. S. Hough meets this point admirably, though open to the defect of large calking surfaces exposed to damage, as compared with ordinary deep tanks. As compared with ordinary double bottom tanks, the deep centerline tank is considerably less liable to damage and possesses other advantages to compensate for the large riveted areas.

It would appear to be altogether just to allow properly designed lumber steamers to load deeper than ordinary cargo steamers, on account of the buoyancy of the cargo. The beam of the vessel is a fundamental consideration in this, and in the present freeboard regulations beam is only casually mentioned. It is safe to say that the problem is by no means unsolvable, and that with the vast amount of data recently prepared a way will be found that will be just to all concerned, owners, underwriters and crew.

An interesting solution of the lumber steamer problem is that afforded by the *William O'Brien,* a vessel designed by Mr. E. S. Hough, and built at the New York Shipbuilding Company's yards in Camden, N. J. The deck load is carried in a light superstructure over the three forward holds, the fourth being open, as usual. The superstructure protects the dry and finished products from the sea, and in addition the high sides extend the range of stability. The lumber is lifted aboard in heavy iron straps, making packages four feet square, which are used again to unload at the other end of the trip. This vessel is served by special overhead loading and unloading plants, and consequently does not carry her own gear. The high sides would necessitate an elevated control platform for operating the winches in an ordinary, self-discharging lumber steamer.

This superstructure, if fitted all the way between poop and forecastle, would have marked advantages to compensate for its extra first cost, namely:

1. Protects cargo from loss by wave action.
2. Lower insurance rates for under deck cargo.
3. Stronger ship due to great depth of girder.
4. Enables large hatches to be more easily obtained, due to height above sea.
5. Enables other cargoes to be carried to full capacity of the ship, protected from the weather.

These advantages apply to a vessel carrying wet, unfinished lumber, as well as one carrying dry, finished cargoes.

Motive Power

Turning now to motive power, the last ten years have witnessed greater changes in this field than can readily be grasped. Ten years ago it is safe to say that the well-nigh universal method of cargo ship propulsion was by means of compound or triple expansion engines, with an occasional quadruple expansion engine here and there. Scotch boilers were in undisputed possession of the field, and were coal fired; this can be said because paddle wheels were not applied to ocean cargo steamers during our period. What do we find to-day? The whole marine engineering world is considering several alternatives. Steam turbines have made wonderful strides, motor ships are quite common, and cargo steamers are being driven by high speed turbines, mechanically geared down to normal propeller speeds. Electric reduction gear is being seriously proposed, likewise hydraulic gearing, with a view to using turbines for prime movers. Scotch boilers still hold the field for ocean cargo ships, except in isolated cases, but oil fuel is being used in many routes where the supply is assured, coal no longer being, to all intents and purposes, universal.

Reciprocating engines are still the principal type of motive power, but geared turbines are making a splendid start, being capable of, roughly, a knot greater speed on the same fuel consumption in an average ship.

Motor ships, particularly when twin screws are adopted, are making progress for low powers only. Electric drive has been tried in a few cases, but has hardly emerged from the purely experimental stage for cargo ships.

Of the several alternatives the geared turbine looks the most promising for vessels of this type, particularly since improved methods of gear cutting have been adopted. The number of cargo vessels now at sea and under construction fitted with mechanical gearing and steam turbines is in excess of thirty. Reports from the vessels in service state that there is no appreciable wear on the pinion teeth after being in constant operation upwards of two years.

The saving in economy of fuel consumption for a single screw installation averages about 15 percent, and in case of a twin screw installation a saving in fuel consumption will be at least 20 percent over reciprocating machinery.

Another point to be considered in applications of this type is the question of saving in weight of machinery and engine room space. A geared turbine installation effects a saving in the machinery weights averaging 10 percent, and in many cases one or two frame spaces can be saved in the length of the engine room.

To keep up with the adoption of internal combustion propelling engines, attention is being given to reducing the number of steam auxiliaries, though the exhaust gases from the main engines can be used for keeping steam on a donkey boiler. Particular attention is directed to the hydro-electric steering gear now being fitted on quite a number of ships. An oil-fired donkey boiler and steam winches for port use offer a good method for cargo and anchor handling purposes. Motor-driven pumps are common, and so on, down the list.

Present Status of Ocean Cargo Ships

As regards the present status of ocean cargo ships, it is evident that we are at the beginning of a period of increased activity; large ships are the rule, notably so in oil tankers, in which longitudinal framing is firmly established. All eyes are turned towards new types of propelling machinery and considerable economies of propulsion are confidently looked forward to, and have already been realized in some instances, notably in the case of geared turbines and of motor ships of low powers.

The increased attention given to safety of life at sea will probably result in cargo vessels being required to carry boats enough for all hands on each side of the ship, this being law in Great Britain already. Subdivision as effective as in passenger ships is not practicable, except in a few cases, such as oil tankers and bulk carriers that are unloaded by ample overhead gear.

Tug Boat S. M. Otis Equipped With Oil Engines

The 45-foot tug boat *S. M. Otis,* illustrated, which is owned by the Otis Manufacturing Company, New Orleans, La., has been in service for over four years in British



Motor Tugboat *S. M. Otis*

Honduras, towing rafts of mahogany logs from the northern boundary down to Belize. This boat draws about 3 feet of water and makes about 9½ or 10 miles an hour in light condition. She is equipped with a 45-horsepower, three-cylinder Mietz & Weiss marine oil engine manufactured by the August Mietz Foundry and Machine Works, New York. In addition to towing mahogany logs in rafts of about 300 logs, the boat transports laborers and provisions from place to place as required.

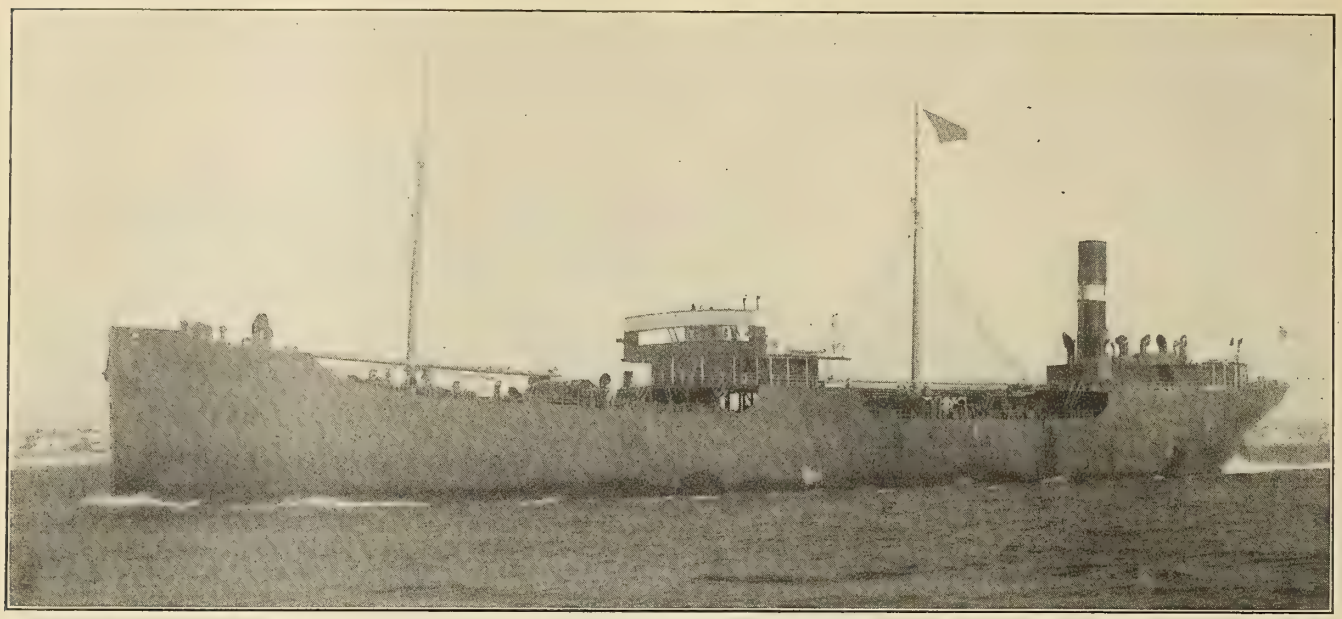


Fig. 1.—S. S. *Texas* on Her Maiden Voyage

Oil Tank Steamship Texas

Eleven-Knot Vessel of 9,100 Tons Deadweight Capacity Built at the Fore River Shipyard

The first of the Texas Company's new fleet of oil tank steamers to be completed is the *Texas,* built by the Fore River Shipbuilding Company, Quincy, Mass. The vessel has two continuous steel decks, a raised forecastle, bridge and poop decks and a lower deck in the package freight hold. The hold is divided by oiltight bulkheads into compartments for sixteen main oil cargo tanks, sixteen summer tanks, fuel oil tanks, two pump rooms, a cargo hold forward, machinery space aft, deep trimming tanks both forward and aft and a double bottom under the engine and boiler space. The ship is schooner rigged, with two steel masts. The principal dimensions are as follows:

Length over all.....430 feet
Beam ..... 56 feet
Depth .....32 feet 9 inches
Load draft .....25 feet 6 inches
Deadweight carrying capacity at above draft, 9,100 gross tons
Capacity of cargo tanks.....73,000 barrels
Capacity of cargo tanks.....3,066,000 gallons
Speed .....11 knots

Propulsion is by a single screw driven by a three-cylinder, triple-expansion engine, with cylinders 26½ inches, 44 inches and 74 inches diameter by 51 inches stroke, designed to run at a maximum speed of 75 revolutions per minute. Steam is supplied by three single-ended Scotch boilers, 15 feet 3 inches diameter by 11 feet long, working at a pressure of 190 pounds per square inch. The boilers are oil-fired, being fitted with a mechanical atomizing system. The vessel is also equipped with a donkey boiler.

The vessel has been designed to carry various grades of refined oil without danger of mixture. The cargo pumping system has been carefully worked to the highest point of efficiency. All living quarters, which are carefully planned, are provided with a steam heating system and

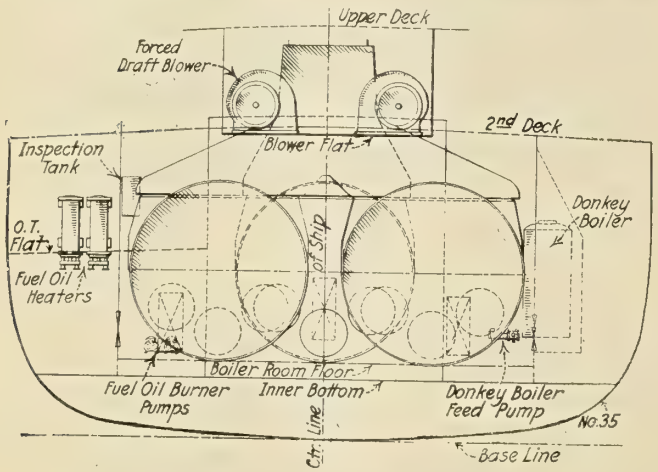


Fig. 2.—Section Through the Boiler Room

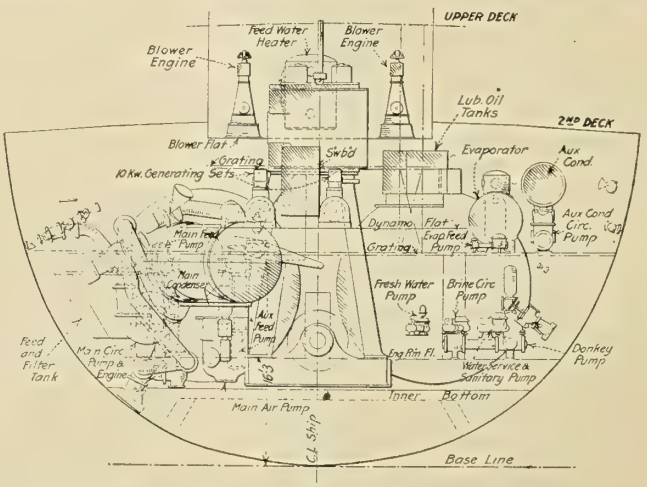


Fig. 3.—Section Through the Engine Room

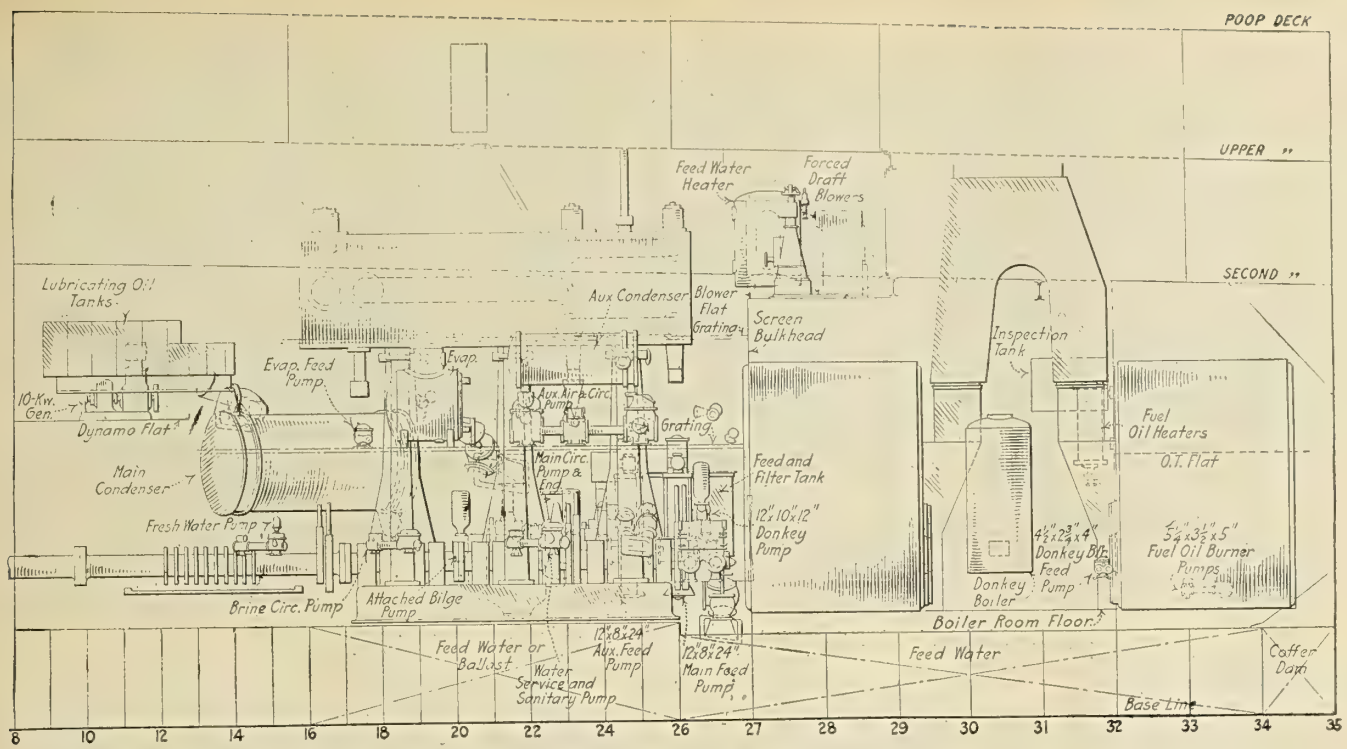


Fig. 4.—Longitudinal Section Through the Machinery Space

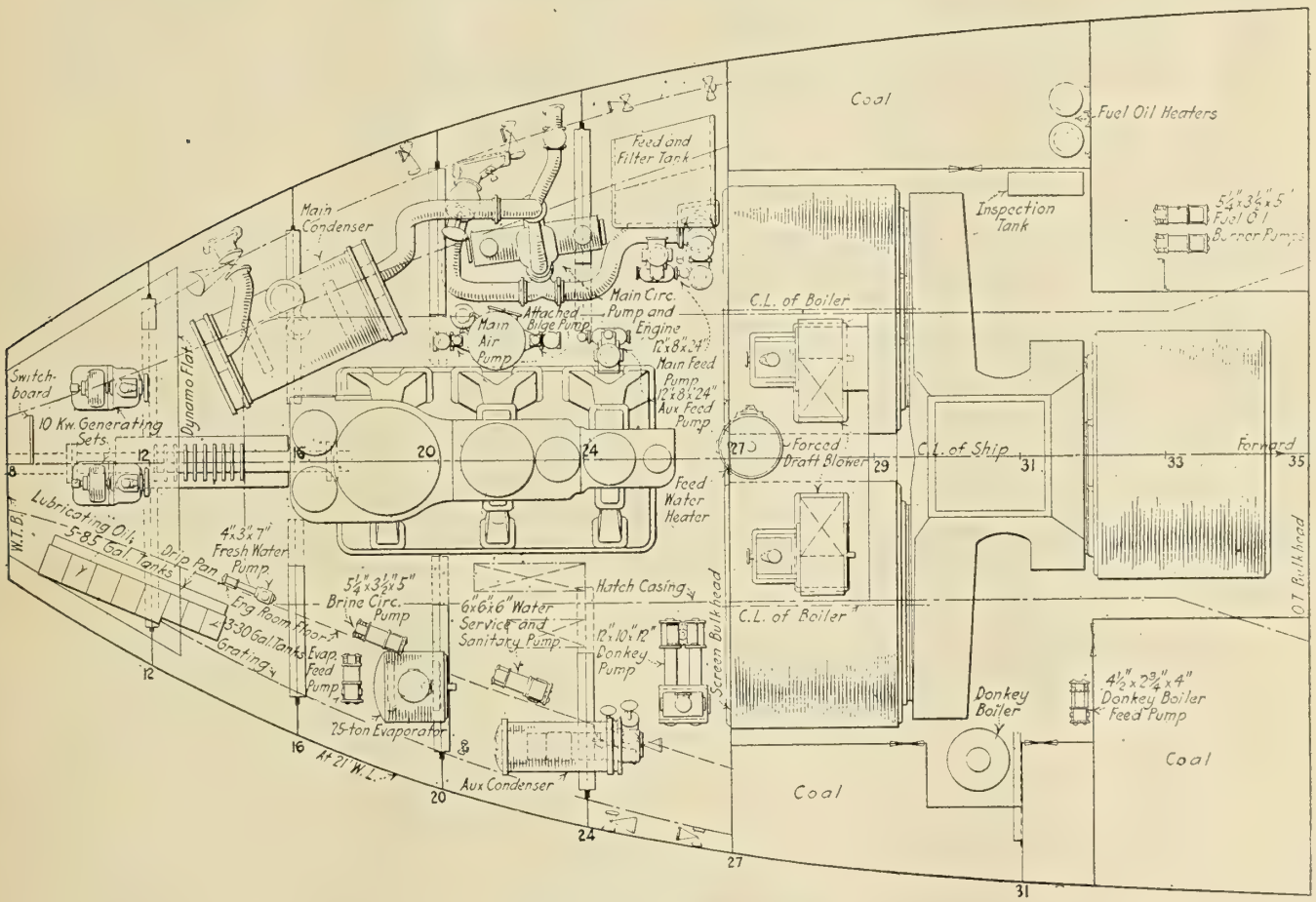


Fig. 5.—Plan of Machinery Space

steam heating coils are provided for the fuel tanks and such other tanks as may be used for heavy oil. Steam fire-extinguishing pipes are also run through all tanks. The equipment of the ship also includes a refrigerating plant and a complete electric lighting outfit. The vessel was designed by Mr. George B. Drake, assistant manager of the marine department of the Texas Company, New York.



Fig. 1.—Model of Submarine Mother Ship Built by the Fiat-San Giorgio, Spezia, Italy

Need of an Efficient Mother Ship for the Submarines of the United States Navy

Description of New Type of Submarine Mother Ship Designed by Major Laurenti for the Fiat-San Giorgio, Spezia, Italy

BY R. G. SKERRETT

A good deal of misguided energy is being spent in this country in urging very extensive additions to our submarine flotilla. The term "misguided" is used because the campaign for increase totally ignores our deplorable deficiency, due to shortsightedness, in other branches of this underwater service. The story of the loss of the *F*-4 should bring this lack to public attention, and there should be no lagging on the part of our citizenry in demanding that our shortage be corrected with the least possible delay.

The United States submarine *F*-4 sank outside of Honolulu harbor on March 25 while maneuvering submerged, and her shattered hull was not brought again to the surface until August 29, when it was towed into port and made ready for dry-docking. The official inspection of the stricken craft disclosed that the immediate cause of her destruction was due to an explosion of battery gas, but unquestionably the primary or promoting cause was some structural weakness through which sea water found its way into the cell compartment.

We must remember that such a weakness might be occasioned in a variety of ways. Barnacles or some other tropical marine growth might have clogged an outboard connection leading to a ballast tank or the seating of an

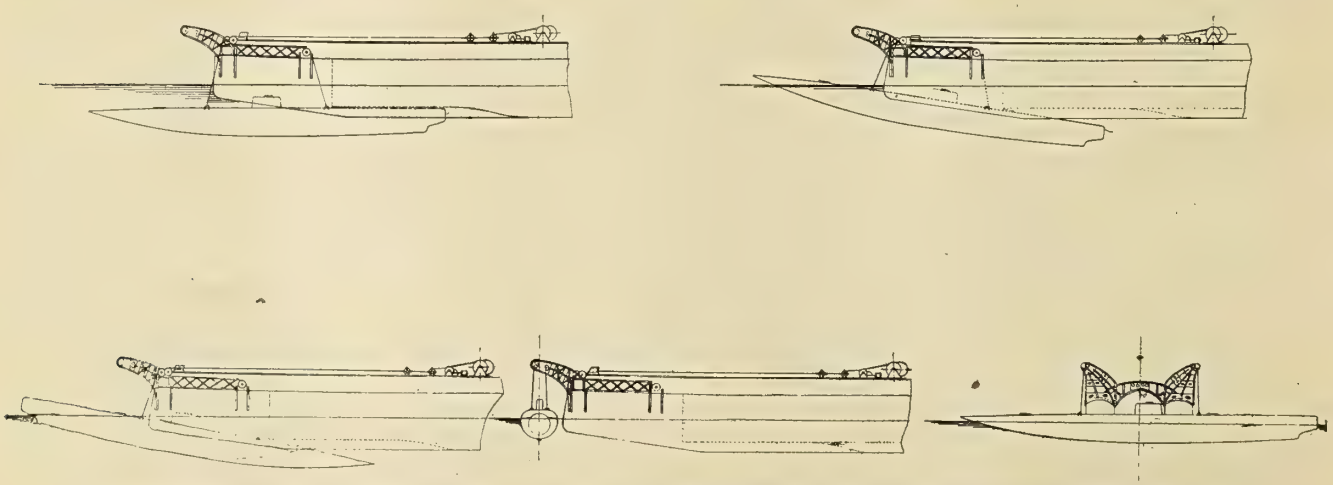


Fig. 2.—Diagram, Showing Method of Raising a Foundered Submarine with Gear at the Stern of the Mother Ship

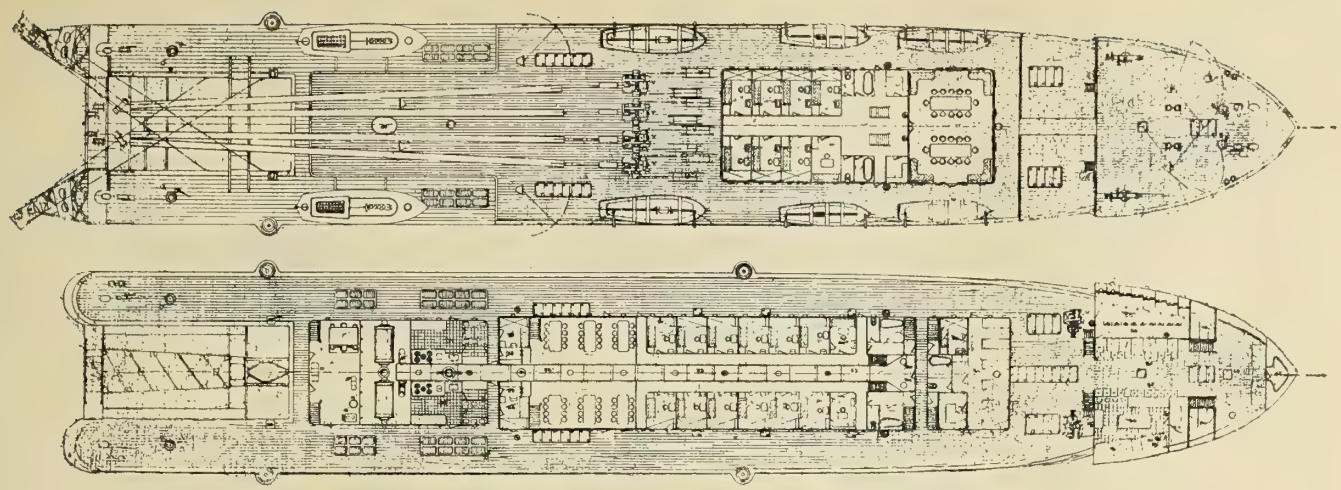


Fig. 3.—Deck Plans of Mother Ship

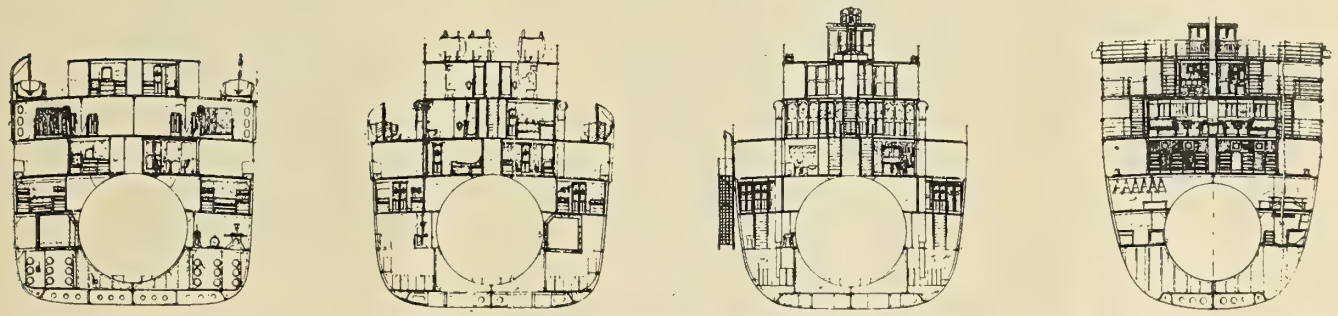


Fig. 4.—Sections Through Mother Ship Forward of Amidships

exhaust or intake valve. Again, acid from the cells, spilled by the motion of the boat, might have reached the hull plating and damaged it, and, possibly, vital steel work might have corroded from other causes and escaped detection. Anyway, the weakness yielded under the pressure of a normally deep submergence. There was sudden gassing, there was a spark, either from a short circuit or the working of a switch, and a fatal explosion followed. Control of the boat was lost, and down she quickly sank to nearly 300 feet, and in through the breach, no matter how moderate, the sea rushed under that great head. The men inside, if not killed by the explosion, had no chance, and were probably drowned before they had time to recover from the initial shock.

The catastrophe might, in all likelihood, have been avoided had we the proper auxiliary equipment for our submarine divisions in the shape of thoroughly up-to-date depot or mother ships. By mother ships we do not mean makeshift mobile supply bases, but vessels of a composite nature capable of ministering to the peculiar needs of underwater craft. To-day we are woefully lacking in this very important particular, and any further increase of our submarines without additions of this sort, too, amounts to little short of a bid to disaster and more numerous unnecessary losses.

The hulls of all of our submarines are of steel, and steel will rust and pit deeply unless it be watched continually where exposed to water or to moisture. The least evidence of corrosion must be dealt with promptly and the scraped surface repainted. In no order of vessels is this vigilance more necessary than in underwater craft. Unfortunately this is not quite practicable to the desired degree in certain of the water-ballast tanks, and even if possible it is seriously debatable if the work of scraping and painting is done as thoroughly as the nature of the risk of submarine service exacts. Therefore, some check should be available for the speedy and safe detection of structural failures due to insidious corrosion in out-of-the-way parts of such complex boats.

An ordinary surface craft is docked for examination at regular intervals in order to see that she is fit for sea service and capable of floating. A submarine, on the other hand, when similarly dry-docked, is inspected, scraped and painted for the purpose of making her equal to a twofold service: on the surface and below the waves. Not only that, but she must be strong enough to withstand a compressive force due to a sudden and deep submergence if she be carried down by accident or intentionally submerged to that depth for maneuvering or military purposes. It must be clear that merely dry-docking and visual examining will not suffice. The only satisfactory inspection would be one that physically simulated or duplicated the stresses due to actual submergence, and this under circumstances that would permit men to be retained safely inside of her the while.

Of course, this procedure is now pursued by us when testing new submarines at the time of their acceptance trials. Then they are purposely drawn down to a depth of 200 feet, and the inspectors can see or readily trace the source of all leaks. But, alas! this sort of testing is expensive; *it is done only once during the lifetime of a boat,* and it requires a favorable spot where water of that actual depth can be found. Even so, the state of the weather may occasion costly delay. The older a submarine grows the greater is the danger incident to structural deterioration, and, therefore, the more need of sub-

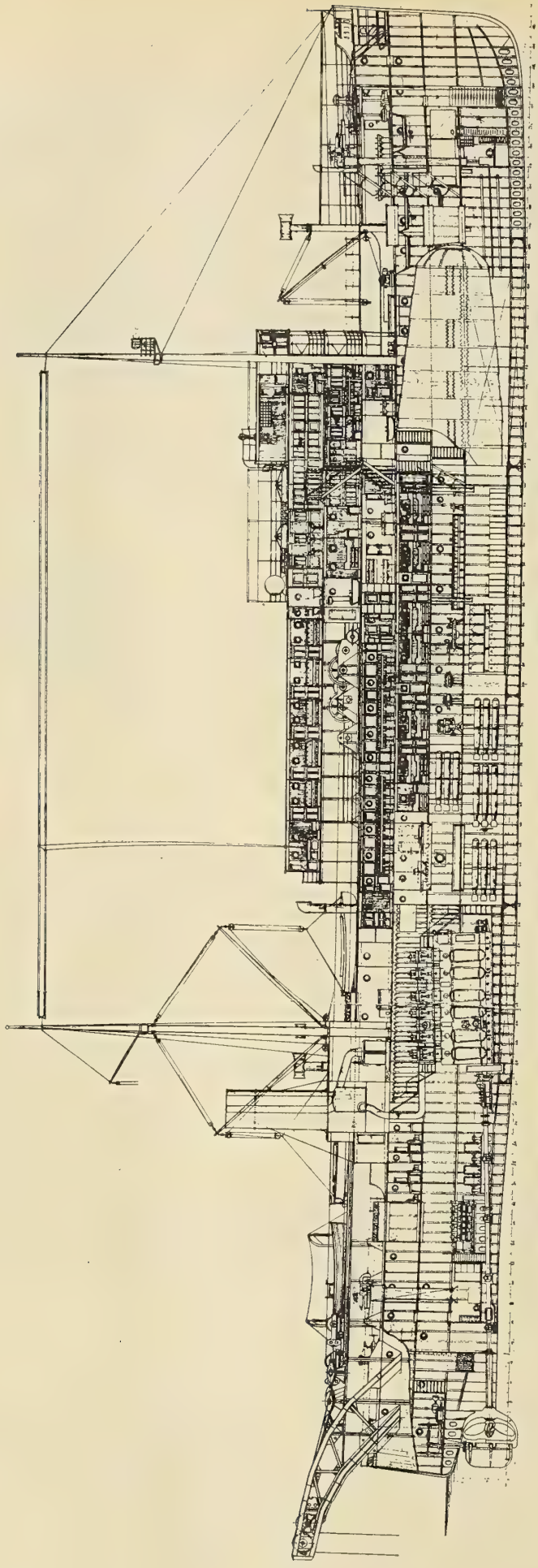


Fig. 5.—Inboard Profile of Submarine Mother Ship Built by the Fiat-San Giorgio, Spezia, Italy, from Designs by Major Laurenti

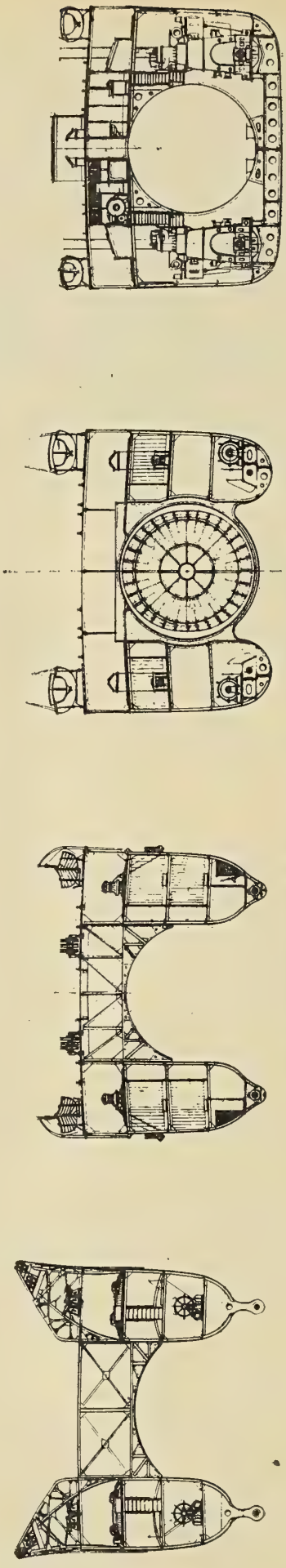


Fig. 6.—Sections Through Machinery Space and at Stern of Mother Ship

mergence tests of this sort. It is not right to expose the crews of these vessels to sudden peril in ordinary peace-time practice when there are facilities available to-day not only for guarding against this menace, but for greatly increasing the military effectiveness of these boats in time of war.

The well-known Italian firm, the Fiat-San Giorgio, of Spezia, has built a special submarine mother and depot ship both for the home Government and for the Brazilian navy, and what we need are three or four of the same kind here. There should be two available for each coast, and more should be built as our flotilla of subaqueous craft grows. The vessels turned out by the Italian yard are designed to discharge manifold duties. They are mobile supply and repair bases containing tubular testing docks and capable of promptly salving a sunken submarine if within the reach of divers. This, as will be readily recognized, is a very notable advance over the simple testing dock evolved by the same enterprising company a few years ago, for the present ships are self-contained and capable of making extended cruises. In turn, they add very materially to the strategic value of a flotilla of submersibles so convoyed.

Submarine Mother Ship Built by the Fiat-San Giorgio

In order that we may get a fair idea of the design of these novel vessels the following general particulars and principal dimensions are given:

Length between perpendiculars	328 feet 00.0 inches
Beam, maximum	51 feet 6.0 inches
Draft when ready for sea and all stores aboard	13 feet 11.25 inches
Total length of cylindrical testing dock	209 feet 11.66 inches
Maximum useful length of dock (internal)	180 feet 2.25 inches
Diameter of entrance (rear end) of cylinder	24 feet 9.66 inches
Internal diameter of cylindrical testing dock	23 feet 4.00 inches
Motive power, two heavy-oil engines driving twin screws.	
Maximum speed	14 knots
Radius of action, at 10 knots speed	4,000 knots

As the present war has amply demonstrated, service aboard submarines is exceedingly exhausting, and in the case of the German U- boats they have suffered from the added handicap of operating from fairly distant stationary bases. It has been with these latter craft largely a matter of physical endurance on the part of the personnel. It was in anticipation of these demands that Major Cesare Laurenti, of the Fiat-San Giorgio, planned this particular order of mother ship. His aim was to provide a place of refuge for tired submarine crews, as well as a source of operative supplies; in fact, a mobile base for a tactical unit of six submersibles—the flotilla to consist of three boats of 400 tons submerged and three of 650 tons submerged.

When mothering a flotilla of this make-up, this depot ship is able to fill four times the fuel tanks of the smaller submersibles and to do a like service three times for the big boats as well. Thus, while tripling or quadrupling, as the case might be, the radius of action of these submarines, this unique craft can cover on her own account a matter of 4,000 nautical miles. The operative crew of the ship is 140 men, and there are spare accommodations for 150 of the personnel of the flotilla. In this way the men of the submarines can be given a chance to rest from time to time, especially when their boats are alongside for repairs, refueling, revictualing, or for the recharging of the batteries of the submersibles. There is also a commodious sick bay.

The mother ship has a reserve of cells suitable for both of the foregoing types of Laurenti submersibles, and, if need be, can supply at once fresh accumulators for each of the six boats to the number of half the total required. This makes speedy substitution possible and amply takes care of the probable maximum demands of the heaviest service stresses. Besides providing new cells, the dynamos of the depot ship are available for recharging the accumulators in the submarines, thus obviating the use then of the engines of the submersibles and, for the time being, allowing the crews of the underwater craft to rest or to attend to other matters.

Propelling Machinery

The ship is driven by two heavy-oil Fiat-Diesel two-cycle reversible engines, each of six cylinders and capable of developing at full speed 3,200 brake horsepower, and when making 130 revolutions a minute, able to develop 2,200 brake horsepower. The air compressors are of the three-stage type and are designed to serve the double purpose of starting the engines and pulverizing the fuel. They are directly driven, but are so arranged that they can be easily disconnected from the motors in order to facilitate their repair when the engines are working. Each motor is fitted with a spare compressor driven by an auxiliary engine. These compressors are designed to work to 50 atmospheres, and will be able to actuate the engines at one-third of their normal charge. Besides, there are two other compressors, electrically driven, for service in charging up to 175 atmospheres, when this is required for recharging the air flasks.

With the latter compressors it will be possible to refill the flasks of the submersibles with compresed air at 175 atmospheres. For this purpose there is a distributing system extending the length of the depot ship with connections at many points by which piping can be led conveniently to the submarines alongside. Assuming the flasks of the boats to be exhausted, the capacity to recharge and the time required by this plant would be as follows:

To recharge three of the 650-ton boats	6.5 hours
To recharge two 650-ton and one 400-ton boats.	5.45 hours
To recharge one 650-ton and two 400-ton boats.	5.0 hours
To recharge three 400-ton boats	4.15 hours

Interchange of Crews

In this way any drain on the motive power of the submarines would be avoided, and, while undergoing recharging, the personnel of the submersibles could be otherwise employed or permitted to rest, if that be desirable. It must be understood, of course, that the bigger part of the crew of the depot ship is composed of trained submarine men, and this allows of an exchange of duties and regular rotation in underwater work. The advantage of this must be obvious.

There are two electrically driven auxiliary pumps serving the forced lubrication system of the engines. These pumps have a capacity of 30 tons per hour. In addition, there are two bigger electrically driven pumps with an hourly capacity of 100 tons, designed for auxiliary circulating duty with the main propelling engines. With these precautions the continual working of the engines is amply assured.

There are to be two electro-generating sets of 150 kilowatts placed in the engine rooms. These generators

are driven by internal-combustion engines and will furnish all the power needed to operate the various electrical apparatus and motors aboard the depot ship.

In order to make even more certain of the uninterrupted working of the main and auxiliary engines, another spare compressor is provided, steam driven, having a capacity of 20 liters per minute at a pressure of 175 atmospheres. The principal purpose of this compressor is to supply air for starting the electro-generating set in case the air flasks on board the ship should be exhausted. It will help also to refill the ship's flasks, and, in time of urgency, to recharge the flasks of the submarines, thus supplementing then the other compressors. There is another steam-driven compressor of the plunger type capable of delivering 1,200 liters per minute at 6 atmospheres. This is connected with the cylindrical dock and provided for the purpose of testing submarines when inside that structure.

Operation of Testing Dock

We have already described the Laurenti submarine-testing dock in its simple form. Essentially there is no difference in the present apparatus save that the cylinder is inside of the mother ship. The cylindrical testing dock is formed of high tensile steel, the forward end being permanently sealed and the stern end closed by a removable steel caisson of globular form. This caisson has inherent stability enough to maintain it upright when floated free of the entrance to the testing dock. The draft of the caisson is controlled by water ballast. When in the sealing position the caisson is seated upon a heavy annular india rubber gasket, and is locked so as to insure water tightness whether the maximum pressure be exerted from within or outside of the dock. To release this gate, just enough water ballast is blown to lift the caisson a few inches. Then it can be swung around upon its vertical axis until in line with the longitudinal centerline of the cylinder. In this position it can be drawn out and aft so as to give a clear passage either for the entrance or the exit of a submarine.

It is hardly necessary to go into details regarding the modus operandi of testing an underwater boat; but for the sake of those unfamiliar with the earlier form of the Laurenti dock it will probably suffice to be told that a submarine, after entering the dock and settling upon the blocks arranged for her and being centered vertically by means of other blocks so she can not rise, is surrounded by water which fills the cylinder. Then pressure is applied to this water by means of the plunger pump, and gradually this is raised to represent the hydrostatic stress of any equivalent submergence. All the while there are people inside of the submarine for the purpose of inspection, and the officer in charge is in telephonic communication with the engineer directing the working of the pressure pump. Instantly the pressure upon the submarine can be reduced by the stopping of the pump and the opening of suitable exhaust valves.

The whole operation of testing is exceedingly simple and can be carried out in harbor or at any convenient point where the mothership and the submarine rendezvous. These tests can be made at frequent intervals and unsuspected weaknesses can thus be promptly detected and needless risk of life and property avoided. For salvage work in connection with a sunken submarine, the special windlass and the derrick placed at the stern of the ship would suffice. Some of our illustrations show just how this apparatus would work when raising a foundered underwater boat to the surface.

Both the Italian and Brazilian motherships are armed with rapid-fire guns for the purpose of dealing with either destroyers or enemy submarines. Each of these vessels carries four quick firers of 100-mm caliber and four of 57-mm caliber, together with an ample supply of ammunition.

Motor Ship's Five-and-a-Half Years' Service

In the early part of 1912 the Diesel-engined motor cargo ship *Sembilan* left Europe for the Dutch East Indies, where she has remained in steady service ever since, giving to her owners the same consistent work that could be expected of a high-class steam vessel. The performance of this ship is all the more creditable when it is considered that her engine was built before the advent of the much-discussed motor ship *Selandia*. In fact, the *Sembilan* was the second seagoing vessel to be installed with direct-reversible Diesel engines, the first being the *Vulcanus*.

Placed in service in November, 1911, the *Sembilan* plied between Holland and England for several months before her departure to the other side of the world, in order that her working could be closely supervised. Everything being considered satisfactory by her owners and builders, she soon left for Weltevreden, Batavia, Java. According to reports from Mr. J. Jameson, chief engineer of the Koninklijke Paketvaart Maatschappij (Royal Packet Line), during her first three years' service in the Dutch East Indies the vessel completed ninety voyages, and the total amount spent in repairs was $2,400 (£490); also very little time was lost due to being laid up for this purpose. It should be noted that the *Sembilan* is engaged in a service where there are practically no facilities for proper repairs, and to maintain a regular schedule a ship must have reliable machinery. Four other ships with the same type of propelling machinery are engaged in the same service, and none has returned to the builders' yard for repairs.

The *Sembilan* was built by the Netherlands Shipbuilding Company, of Amsterdam, and her machinery was designed and constructed at the Werkspoor Works of the Netherlands Engineering Company, also of Amsterdam.

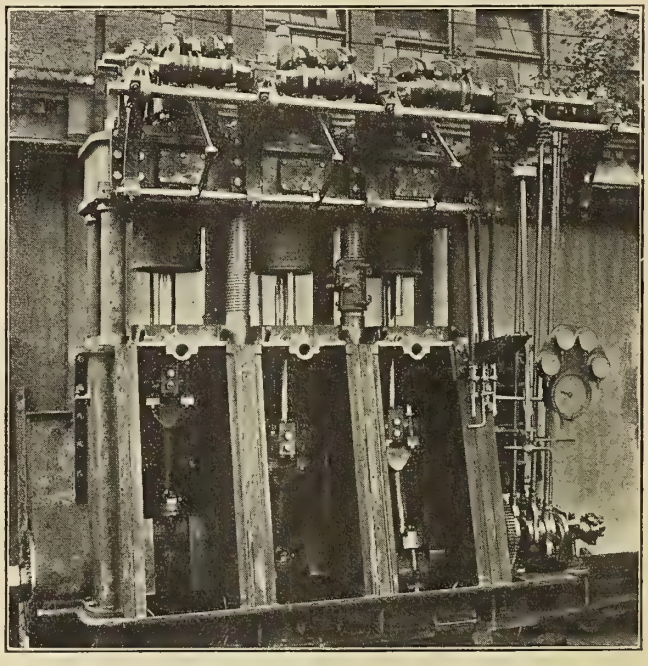


Fig. 1.—Reversible 250 Horsepower Diesel Oil Engine, Showing Crank Chamber Doors Removed

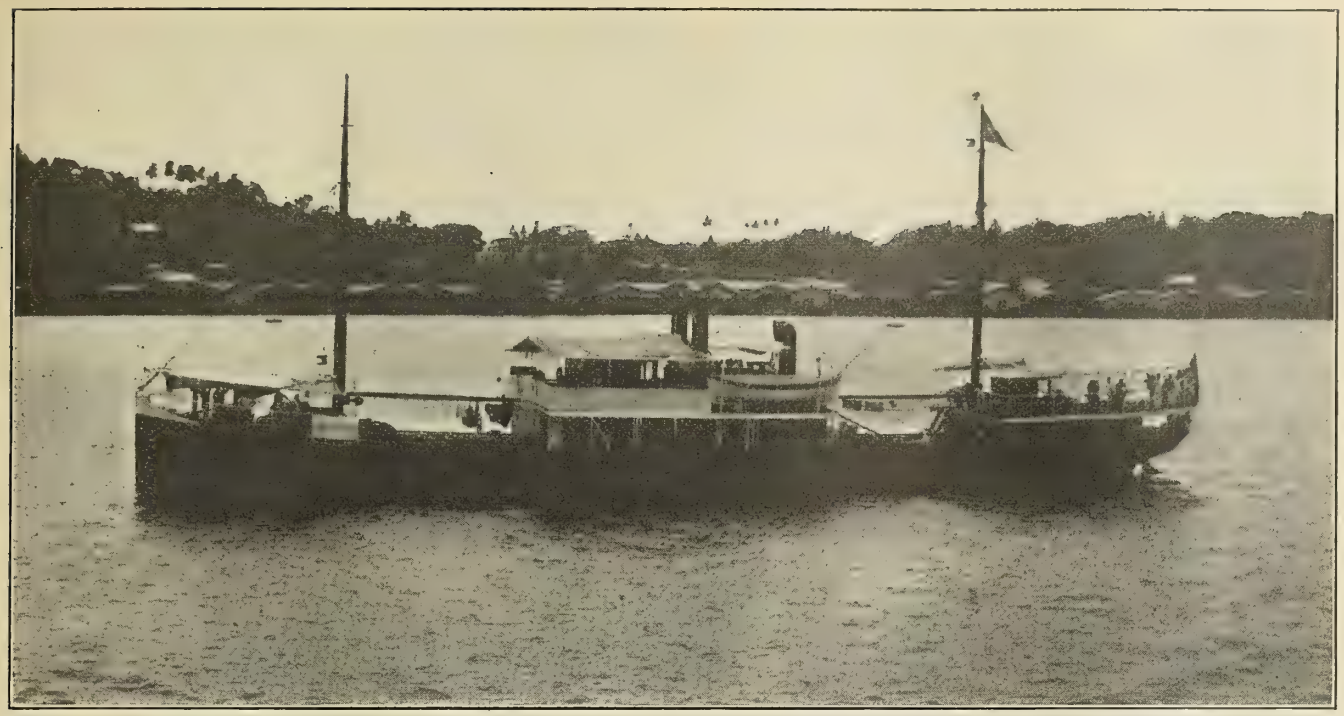


Fig. 2.—Werkspoor Diesel-Engined Motor Ship *Sembilan*

The vessel is 152 feet long by 26 feet beam and has a carrying capacity of 300 tons, on a maximum draft of 9 feet. Her gross tonnage is 372, and her net tonnage 132 tons. In appearance there is little to distinguish her from an ordinary steam cargo vessel, except that her twin funnels are arranged thwartships, one being used for ventilation and the other for the exhaust gases. Her average loaded speed is 8 knots, or 9 knots light, yet her service fuel consumption of residual oil, including auxiliaries, is not over 180 gallons per 24-hour day.

Her main engine consists of a four-cycle type, directly reversible, Werkspoor crosshead Diesel-type motor with three cylinders, 16-inch bore by 20-inch stroke, delivering in aggregate 250 brake horsepower at 200 revolutions per minute. At the forward end of the engine is coupled a three-stage air compressor, which supplies air to storage bottles for starting, reversing and fuel injection. Fuel is injected at 900 pounds per square inch, but for starting, air is admitted to the cylinder at 225 pounds per square inch. At the forward end of the engine room there is a Werkspoor-Diesel engine of 25 brake horsepower, which drives a three-stage air compressor for operating the deck winches. This compressor can be used for charging the storage tanks in case of breakdown of the main compressor.

In the engine room there are two engineers and two greasers, or a saving of three hands, compared with steamers of similar capacity on the same service. The remainder of her crew consists of the captain, two mates, bo'sun, carpenter, steward, cook, four deck hands and two boys, her particular service calling for this large crew.

Lloyd's Quarterly Shipbuilding Returns.—According to Lloyd's returns, which only take into account vessels of 100 tons and upwards, the construction of which is actually begun, there were 424 merchant vessels of 1,423,435 gross tons under construction in the United Kingdom at the close of the quarter ended March 31. The tonnage now under construction in the United Kingdom is about 60,000 tons more than that which was in hand at the end of the last quarter, but about 164,000 tons less than the tonnage building twelve months ago.

Annual Meeting of the Institution of Naval Architects

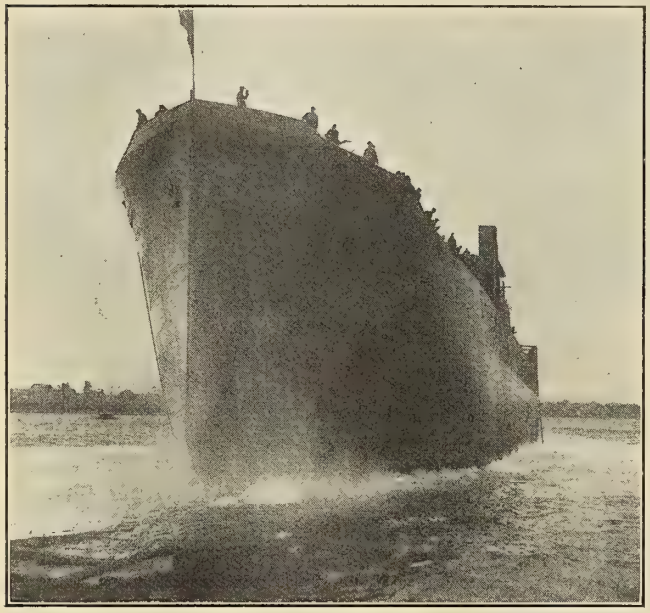
At the annual meetings of the Institution of Naval Architects, held in the Hall of the Royal Society of Arts, John street, Adelphi, London, W. C., on Wednesday, April 12, and Thursday, April 13, the following papers were read and discussed:

1. "On the Work of the Load Line Committee." By Sir Philip Watts, K.C.B., F.R.S., LL.D., D.Sc.
2. "Some Questions in Connection with the Work of the Load Line Committee." By W. S. Abell.
3. "The Laws of Skin Friction of a Fluid in Stream Line and in Turbulent Motion Along a Solid of Great Length." By Charles H. Lees, D.Sc., F.R.S.
4. "Skin Friction Resistance of Ships and Our Useful Knowledge of the Subject." By G. S. Baker, R.C.N.C. (ret.).
5. "Experiments to Determine the Resistance of Bilge Keels to Rolling." By Professor T. B. Abell.
6. "An Experimental Tank Reproducing Wave Motion." By Colonel G. Russo, R.I.N.
7. "A Brief Summary of the Present Position of the Marine Diesel Engine and Its Possibilities." By Engineer-Lieutenant W. P. Sillince, R.N. (ret.).
8. "On the Co-ordination of Propeller Results." By J. Denholm Young.
9. "Note on Maximum Propulsive Efficiency of Screw Propellers." By T. C. Tobin.
10. "Subdivision of Merchant Vessels: Reports of the Bulkhead Committee, 1912-1915." By Sir Archibald Denny, Bart., LL.D.
11. "Strength of Watertight Bulkheads." By J. Foster King.
12. "Some Effects of the Bulkhead Committee's Reports in Practice." By A. T. Wall.
13. "Notes from a Collision Case." By John Reid.
14. "Shipyard Cranes of the Rotterdam Dockyard Company." By M. G. de Gelder.

Launching of the Tank Steamer Cubadist

The steamship *Cubadist,* launched on April 8 from the yards of the Fore River Shipbuilding Corporation, Quincy, Mass., and christened by Miss Lucy Pettengill Currier, daughter of Hon. Guy W. Currier, of Boston, Mass., is a steel tank steamer for the Cuba Distilling Company, New York, designed primarily for the carriage of molasses in bulk, but so arranged that she may be employed in the carriage of bulk petroleum.

The *Cubadist* is a two-deck vessel with poop, bridge and forecastle, and is of the following dimensions: Length



S. S. *Cubadist*

between perpendiculars, 389 feet; breadth, 54 feet 6 inches; depth to upper deck, 32 feet 6 inches.

She will carry about 1,500,000 gallons of molasses on a mean draft of 25 feet.

As this vessel collects her cargo from Cuba and the neighboring islands, special attention has been given by the builders to the question of accommodations for the officers and crew. The quarters for the navigating officers, together with those for the wireless man and chief steward, are located under the bridge deck, so that easy and rapid access can be had to the bridge at all times; the quarters for the engineer officers are located in a Liverpool house around the engine casing on the poop deck, while those for the oilers and firemen are located below the poop deck.

Unlike the usual design of tank vessels, the *Cubadist* has a deep double bottom all fore and aft, and the inner bottom is recessed at the after end in each of the eighteen cargo holds to form suction pockets for the efficient discharging by the pipe line. When carrying molasses the deep tanks above the inner bottom only will be employed, but oil will be carried both in the main cargo tanks and in the double bottom tanks, thus permitting the carriage of 2,250,000 gallons of oil on the same draft as that given above for the molasses.

For the discharging of the cargo there is a pump room amidships in which are located an 18-inch by 12-inch by 18-inch horizontal duplex cargo pump and a 16-inch by 10-inch by 18-inch duplex ballast pump, so interconnected that both pumps may be employed in clearing the main tanks, for one pump may be employed on the main tanks and the other on double bottom tanks simultaneously. These pumps are connected to a 14-inch main line all fore and aft, from which are led 12-inch branches to each tank and so arranged that the liquid cargo may at any time be transferred from one tank to the other through the pumping system.

The propelling machinery consists of one vertical triple expansion engine driving a right-hand propeller. The cylinders are 25 inches by 41 inches by 68 inches diameter, having a common stroke of 48 inches.

Steam will be supplied at a pressure of 190 pounds from three single-ended boilers, 14 feet 2 inches mean diameter by about 11 feet 10 inches long, having a total heating surface of 7,407 square feet.

The *Cubadist* is the first of three vessels now under construction at the Fore River Shipbuilding Corporation for the Cuba Distilling Company, and will be ready for service early this month.

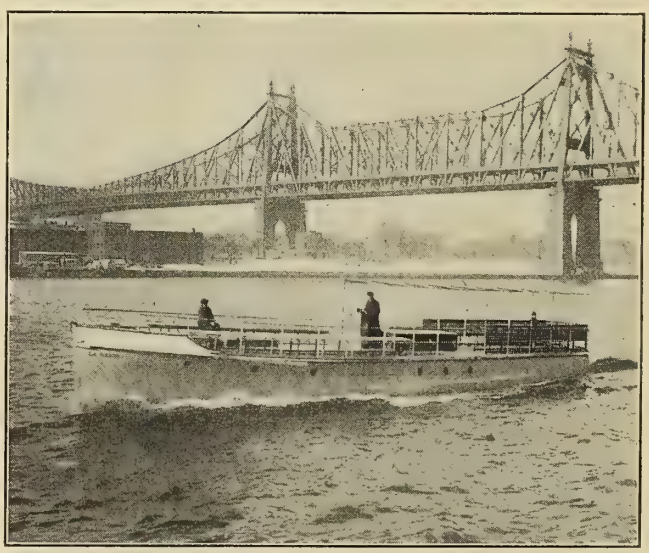
Sixty-Four-Foot Steel Passenger and Cargo Boat for the West Indies

The Welin Marine Equipment Company, Long Island City, N. Y., has recently completed for service in the West Indies the 64-foot steel passenger and cargo boat illustrated. This boat is designed to meet the requirements for carrying passengers, mail and freight, and is fitted for use in the open sea.

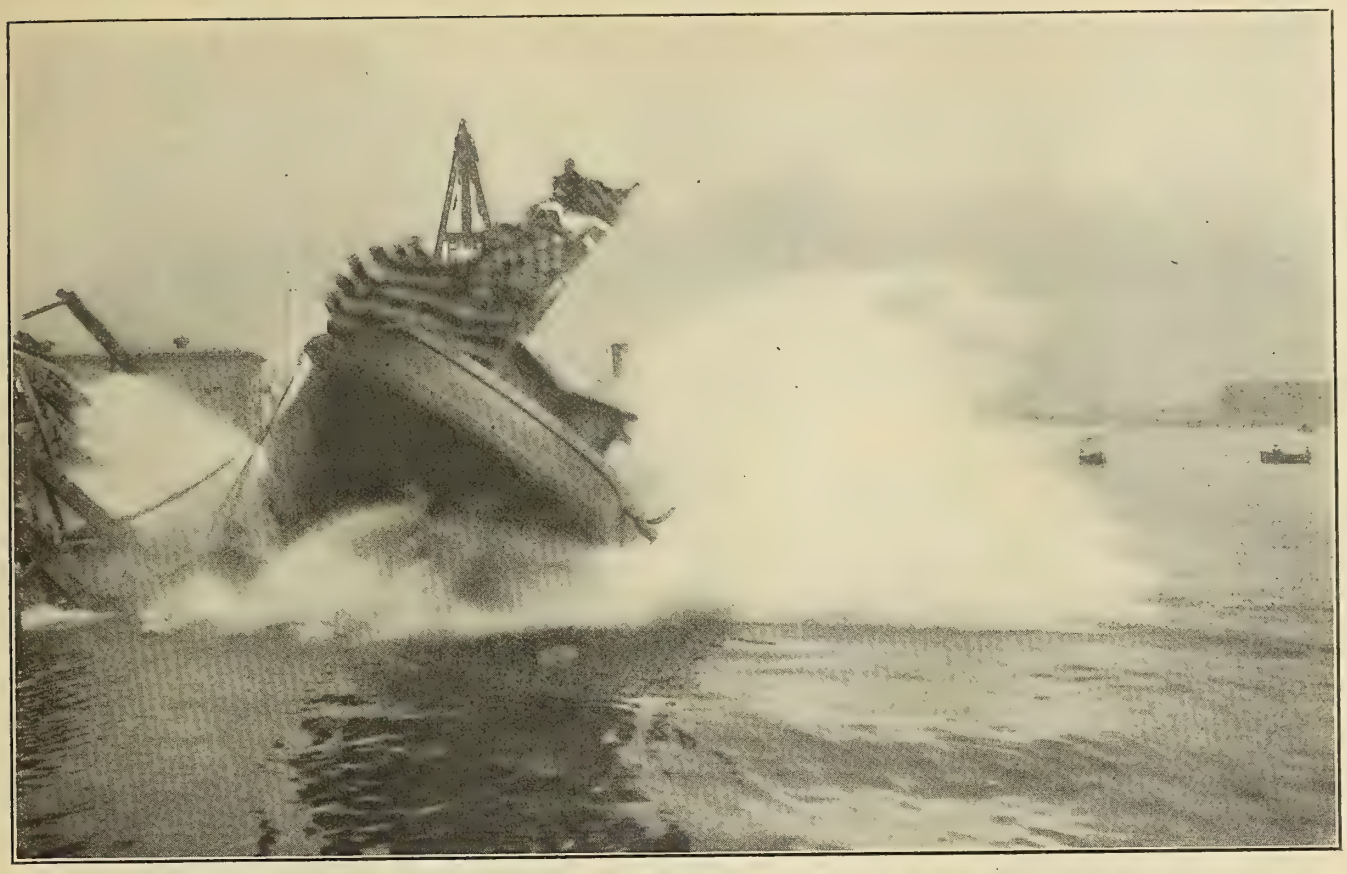
The hull is 64 feet long, 12 feet beam, 5 feet 6 inches depth amidships, and in normal load condition, that is, with a load of from 7 to 8 tons, will have an extreme draft of about 3 feet 6 inches. Propulsion is by a 65- to 75-horsepower Standard motor supplied by the Standard Motor Construction Company, Jersey City, N. J. On trial a speed of 12 1/3 miles per hour was attained.

Seats are provided for 40 second-class passengers forward, and for 25 passengers aft, while standing room is provided for 20 additional second-class passengers.

The boat is framed with 1½-inch by 1½-inch by ⅛-inch galvanized steel angles spaced about 15 inches. No. 12 B. W. G. galvanized sheet steel floors are flanged and riveted to the bottom and flanged straight on top to take cross bars for the flooring. There are three watertight



Steel Passenger and Cargo Motorboat Built by the Welin Marine Equipment Company, Long Island City, N. Y.



Naval Tug *Pocahontas*, Launched Sidewise on Temporary Ways from Sea Wall at the Norfolk Navy Yard

bulkheads, one forward and one just forward and one just aft of the engine room space. The shell plating is of No. 12 B. W. G. galvanized sheet steel.

The engine is located somewhat aft of amidships. Over the engine room is fitted a wooden trunk with a sliding hatch and hinged windows. A built-in berth is fitted on each side of the engine in the engine room. The crew's quarters are forward of the engine room, and access is furnished by means of a large raised hatch. Aft of the engine room there is a flush hatch in the deck, giving access to the cargo space. A gypsy windlass is installed on two nigger heads forward, and a single bitt is fitted aft.

Tug Pocahontas Launched at the Norfolk Navy Yard

The *Pocahontas,* a modern seagoing tug built at the navy yard, Norfolk, Va., was successfully launched on April 1 in the presence of the commandant, industrial manager and officers attached to the yard, the mayors of Norfolk and Portsmouth, Va., and other invited guests. Miss Eleanor Graham Briggs, the daughter of Lieutenant-Commander Wm. G. Briggs, U. S. N., christened the vessel.

The launch was unusual for the reason that the vessel was built on the sea wall, where no permanent ways were possible, and from which she was launched sidewise on temporary ways extending over the sea wall. These ways were designed to tip and drop the vessel off the ends. The tipping of the ways, the angle of the vessel and the enormous splash when the tug hit the water are shown by the photograph.

With an all-steel hull subdivided into twelve watertight compartments, steel superstructure, two pole masts—the forward one being equipped with a cargo boom—together with modern equipment in the way of steam steering gear, steam windlass and towing engines, the *Pocahontas* constitutes an important addition to the auxiliary craft of the navy.

The tug has an overall length of 123 feet 6½ inches, and an extreme beam over guards of 26 feet 7⅞ inches. Her mean draft is approximately 13 feet 3½ inches, with a displacement of 604 tons. The propelling machinery of the vessel is located amidships. Steam is supplied at a working pressure of 200 pounds per square inch by two single-end Scotch boilers arranged fore and aft, the fireroom being fitted for mechanical oil burning exclusively. The main engine is of the inverted-cylinder, triple-expansion, surface-condensing type, of about 800 horsepower. The vessel is particularly well equipped with auxiliary machinery of the latest and most approved design, while the electrical equipment is also thoroughly modern and complete.

A sister ship is being built at the Charleston navy yard, the boilers for which are being constructed at the Norfolk yard.

Launch of Steamship Edgar F. Luckenbach.—The steamer *Edgar F. Luckenbach,* designed by Mr. George Simpson, naval architect, New York, and built by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., for the Luckenbach Steamship Company, New York, was launched on March 29. The vessel is 443 feet long overall, 57 feet beam molded, 31 feet 8½ inches load draft on summer freeboard. The deadweight is 12,800 tons, with a total measurement capacity of 675,000 cubic feet. Propulsion is by a triple expansion engine with cylinders 29, 49 and 84 inches diameter by 54 inches stroke, supplied with steam by three single-ended oil-burning boilers. The designed sea speed is 12½ knots. Six other vessels of similar dimensions are building for the Luckenbach Steamship Company at other shipyards on the Atlantic and Pacific coasts.

Geometry of Wide-Bladed Screw Propeller

Correct Method of Drawing Plans of Wide-Bladed Propeller Explained—Why the Eclipse and Straight Line Method Fails

BY NORMAN A. GRAVESON*

The usual method of drawing a propeller is to consider the projection of any of the succeeding radii, marked off on the propeller face, to be an ellipse, and the plan of this ellipse to be the straight line joining the focal point of the ellipse to the end of the minor axis. To enable the reader to see how far this is true, the accompanying sketch, Fig. 1, shows a cylinder around which is wrapped a line representing a screw or helix.

This helix is generated by projecting the radial advance of a point *A* on the edge of the cylinder on to the axial advance lines of the pitch, or, in plainer words, equal angles of rotation of the point *A* on the edge of the cylinder in elevation correspond to equal advances of the pitch in plan, and the points of intersection form a helix.

In the case of the propeller this helix is the plan of the intersection of the propeller blade with the boss, or of any of the radial lines scribed on the face of the propeller blade. When the propeller blade is narrow in width the use of straight lines in the plan does not affect the shape of the projected surface of the blade, as it will be seen that the helix is nearly straight for a small distance on either side of the center.

Referring to Fig. 2, which shows a helix and a straight line meant to be the plan of an ellipse, originate from the same axis, and both of these lines have the same pitch, but the helix is the true plan of a line wrapped round a cylinder to form a screw, whereas the plan of the ellipse is that formed by a line drawn from the focus of the ellipse to the edge of the minor axis. For the same length of blade cross-section the use of straight lines in the plan shows the length of the section in a fore and aft direction to be shorter than the true length shown by the helix. The distance from the focus of the ellipse to the center line is

equal to $\frac{\text{Pitch}}{2\pi}$

It will be seen that for a wide-bladed propeller the sections along the helix, when projected onto the elevation, are not ellipses, but a curve which will have the same minor axis, but a larger major axis. To project this

* Marshall Scholar.

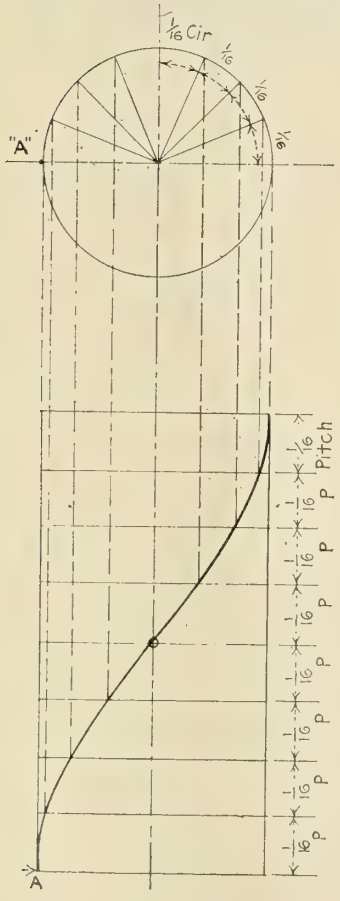


Fig. 1

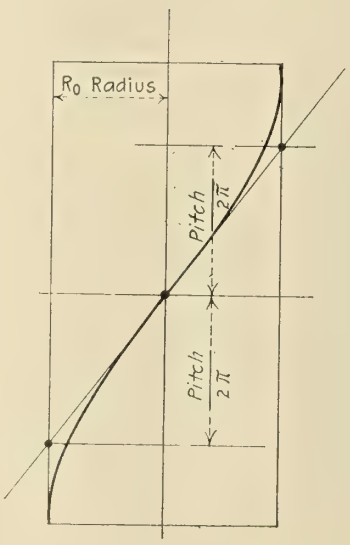


Fig. 2

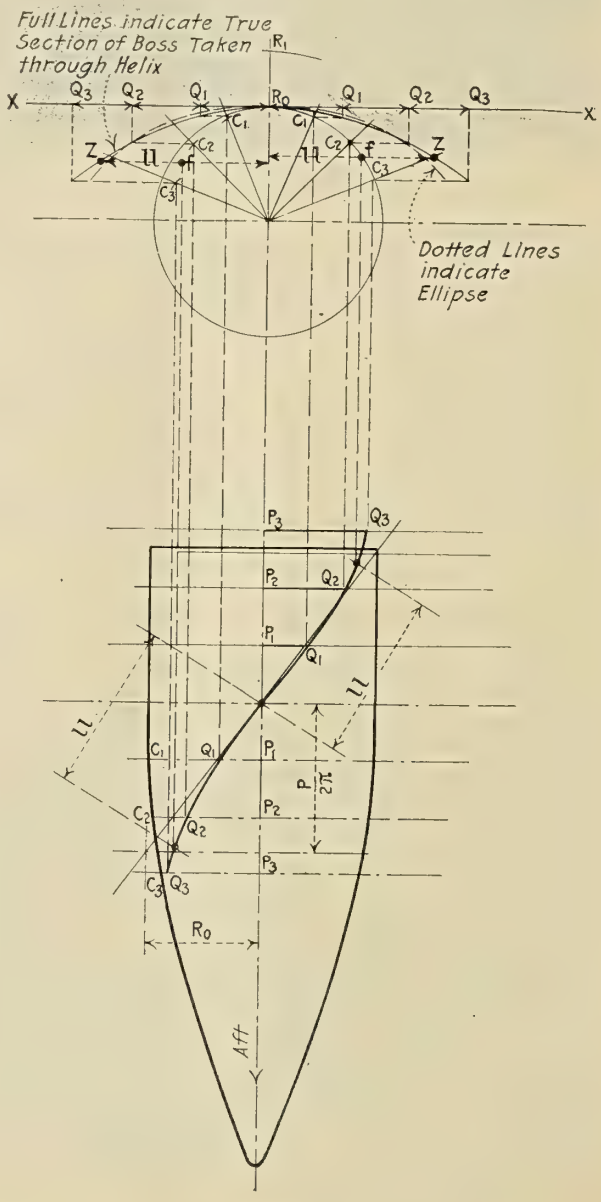


Fig. 3

curve, take as an example a case where the blade root joins the boss and proceed as follows:

Lay off the propeller boss in plan and elevation (Fig. 3). Divide the pitch into 16 equal parts, and, starting from the center line of the propeller in the plan, mark off these increments of pitch in a fore-and-aft direction, as at P_1, P_2, P_3. In the elevation, divide the top half of the circumference of the boss into eight equal parts, as at C_1, C_2, C_3, and drop the *points* C_1, C_2 and C_3 from the elevation onto the lines P_1, P_2 and P_3 in the plan. Join these points and the helix shows the intersection of the blade with the boss in plan.

To develop this curve in the elevation, proceed as follows: Draw a line XX, touching the circumference of the boss at the vertical center line, and on this line, by means of dividers, step off the length of the helix, namely, the portions between each increment of pitch, as Q_1, Q_2, Q_3 in Fig. 3. From these points drop vertical lines to meet horizontal lines produced from C_1, C_2 and C_3. These points when joined form the elevation of the intersection of the blade with the boss. After this, mark off the length chosen for the blade root. When doing this it is policy to take the length of the helix from the forward face to the aft face of the boss to make sure of a strong root section. Then, taking this distance $l\,l$ half the length of blade root (Fig. 3) in the compasses, mark it off from the vertical center line to cut the curve in the elevation at Z. Produce this point horizontally to cut the circumference of the boss at f, and project downwards. This point will be found to lie on the helix at the ends of the blade root.

This now completes the plan and elevation of the curve at the blade root, and by the same process the curves at the radii R_1, R_2, R_3, R_4, R_5 (see Fig. 4) can be drawn, taking care to make the curves long enough to reach the ends of the developed surface of the blade in the elevation, and the helixes in the plan long enough to meet the projections of the curves in the elevation produced downwards.

A good method to use when doing this construction is to take the radius at R_5 (Fig. 4) and divide it into eight equal parts. Join these points on the circumference to the center of the circle, and this eliminates any error due to measuring small arcs off on the small diameter of the boss.

Now lay off the developed surface in the elevation, and where the developed surface cuts the curves formed by projecting the helixes, these points produced to cut the radii R_1, R_2, R_3, R_4 and R_5 give at p_1, p_2, p_3, etc. (Fig. 4) the points which form the edges of the projected surface of one blade. Join the points p_1, p_2, p_3, p_4 and p_5 and the top of the blade, and the shape thus found is the projected surface.

It will be noticed that on Fig. 4 only one-half of the elevation and plan is drawn. The reason for this is that it is easier to construct these halves as shown on Fig. 4 and then trace them on the other side than to do a complete construction straight away, and, again, a certain amount of time is saved in the process.

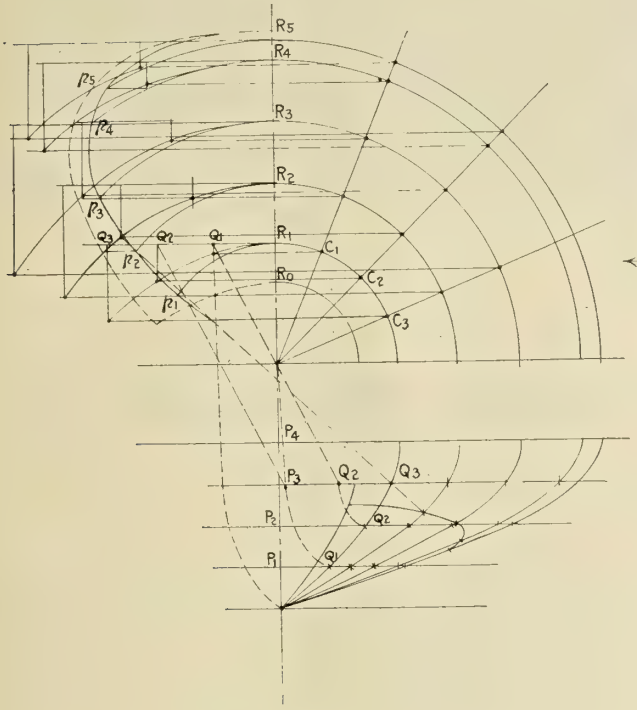


Fig. 4

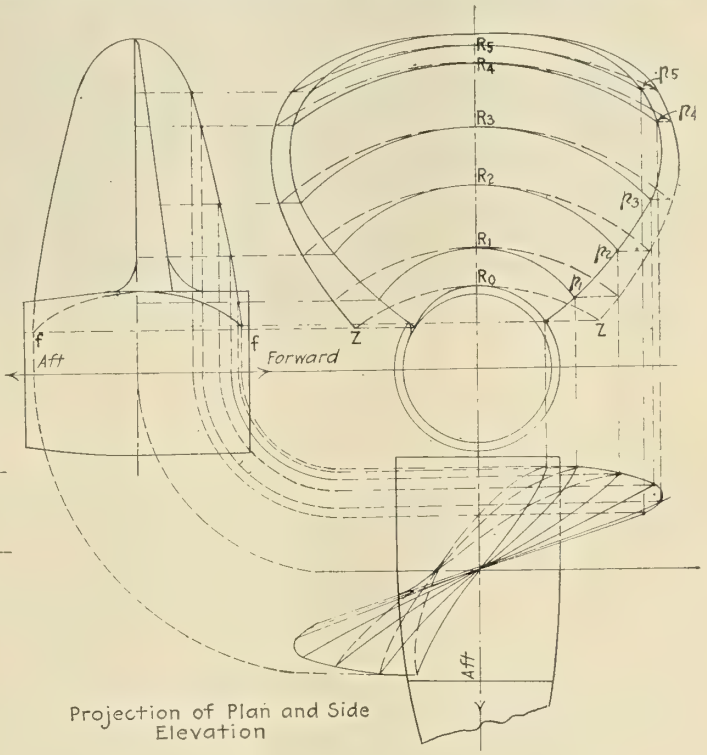


Fig. 5

Plan of Blade

To draw the plan of the blade, project the points p_1, p_2, p_3, p_4 and p_5 vertically downwards to cut the helixes in the plan. This is shown clearly in Fig. 5, and when the points of intersection are joined together the result is the plan of the blade.

When drawing the projected surface and plan of the blade, it is best to draw all the helixes first; then draw the projections of the helixes in the elevation one at a time, projecting down each point on the projected surface separately to cut the corresponding helix in the plan. By doing this the draftsman does not fall into the error of projecting the edges of the projected surface onto the wrong helix.

Side Elevation of Propeller (Fig. 5)

Lay off the side elevation of the boss and draw the vertical center line. Now, dealing with the first radius R_0, this interests the boss at the ends of the developed surface at the points ZZ. Project these points across to the side

elevation of the boss and lay off lines at these heights parallel to the horizontal center line of the boss.

Referring to the plan, the boundaries of the arcs which cut the developed surface are projected across till they intersect the radii R_0, R_1, R_2, etc., and form the outline of the projected surface. Now, these points projected to intersect the helixes in the plan, give the shape of the blade in the plan. Take, with a pair of compasses, the distance from the horizontal center line in the plan to the point on the helix where the edge of the projected surface intersects it, and mark off this distance from the vertical centerline in the side elevation on the line laid off at the height equal to the end of the developed surface, care being taken that the distance on the forward side is laid on the forward side in the side elevation and the aft side on the aft side in the side elevation. These two points *f f*, Fig. 5, are where the blade joins the boss in the side elevation, and if the above process is repeated for each of the succeeding radii R_0 R_1, etc., the side elevation can be completed. But care must be taken that the height at which the points are laid off in the side elevation is where the curve corresponding to the radius cuts the developed surface and not the top of the radius.

The foregoing practically completes the geometry of the wide-bladed screw, and the drawing can be completed to suit the individual taste of each draftsman.

To complete the drawing, in the side elevation mark off the blade thickness at the root and tip; join these and draw the radii where the blade root joins the boss. Take the thickness of the root of the blade at each radii R_0, R_1, R_2, etc., and on the right-hand side of the drawing of the developed surface lay off sections of the blade at each radius, using the blade thickness taken at the radius, the lengths being obtained by stepping out the lengths of each half curve or arc that starts from R_0, R_1, etc., to cut the developed surface.

Plan of the Back of the Blade

In the plan, dot all these blade sections along the edge of the helixes; lay off the thickness at the blade tip, and with a curve join the back edges of the blade sections, and the plan of the blade is complete. The three views of the propeller are now complete, and, to finish the drawing, the detail of the cone nut, gland, wash plate, stop-pins and keys should be given.

The method which has been detailed in the foregoing notes is only advocated for wide-bladed propellers, which, if drawn by the ellipse and straight-line method, are not correct, the projected surface being out of shape, and also the true attachment to the boss being shown smaller than it really is.

Dredge With Geared Turbine-Driven Pumps

First Turbine-Driven Dredge Pump in America Installed on Dredge Columbia in Service at Portland, Ore.

Figs. 1 and 2 show two geared steam turbines driving pumps as developed at Wellsville, N. Y. While direct connection on a steam turbine-driven unit is undoubtedly the best practice under many operating conditions, nevertheless, where steam economy is the first essential, reduction gears not compelled to run at excessive speeds can often be used advantageously to produce the speed and highest efficiency of the driven unit, at the same time permitting the turbine to run at the higher speed which may be demanded for the best steam economy.

It will be seen that the interposition of the gears allows both ends to do their best work, and, since the friction loss

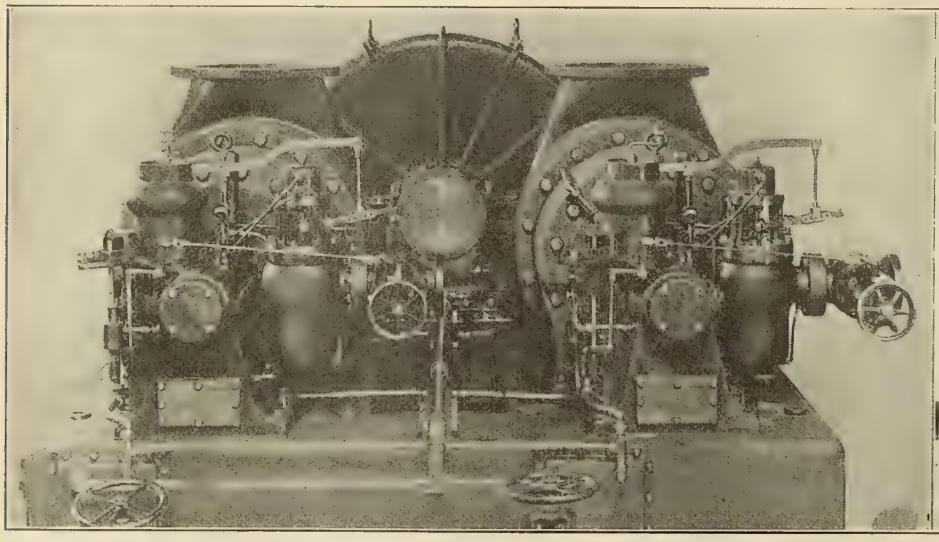


Fig. 1.—End View of Turbines Driving Dredge Pump Through Gearing

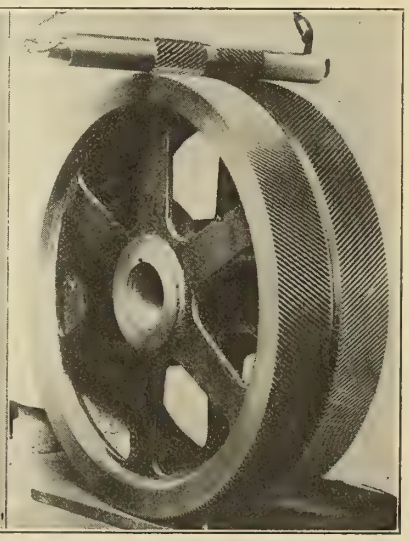


Fig. 2.—Pinion and Gear—Speed Reduction 3,600 to 300 Revolutions Per Minute

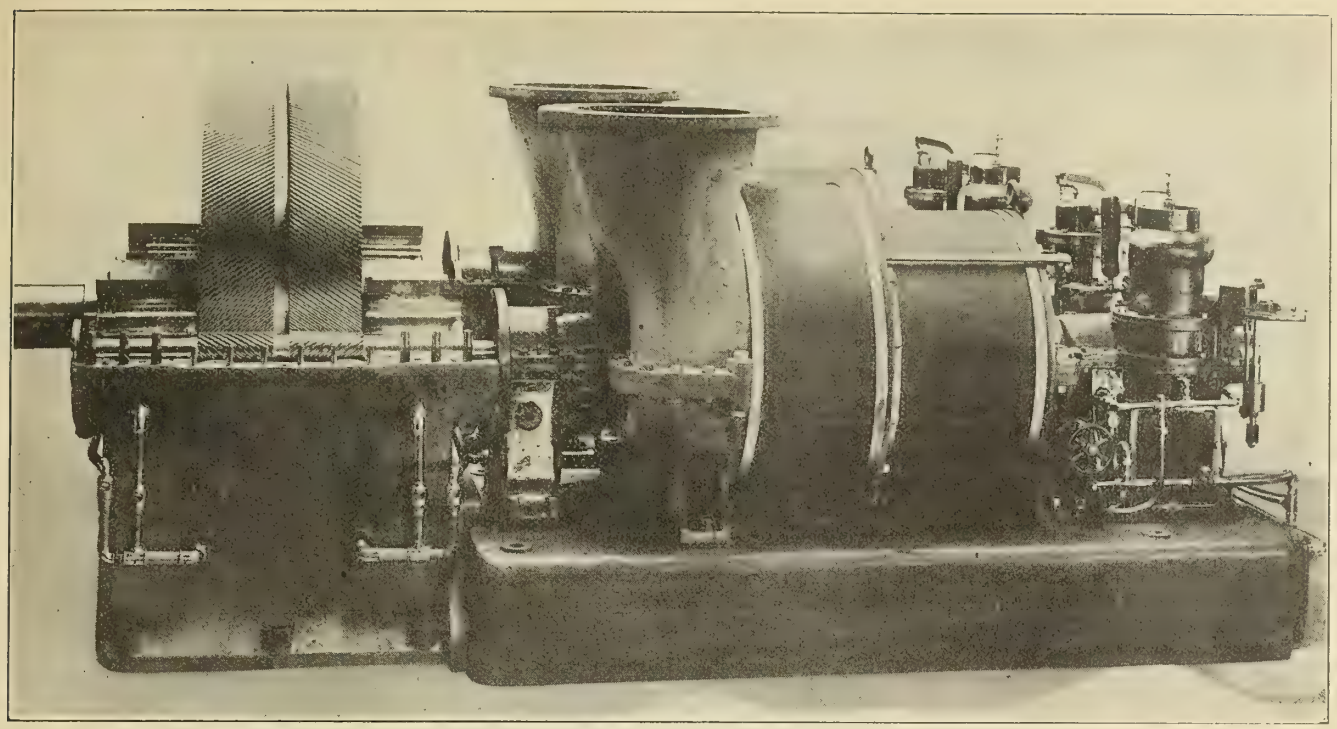


Fig. 3.—Two 1,000-Horsepower Turbines Driving the Pumps on the Dredge *Columbia*

in accurately cut gears is practically negligible, there is an all-around gain. The photographs show two 1,000-horsepower Kerr "Economy" turbines used to drive the pumps on the dredge *Columbia,* of Portland, Ore., through herringbone reduction gears from 3,600 to 300 revolutions per minute, the two turbine pinions meshing with the one gear. This is the first turbine-driven dredge pump ever used in America.

The diagram, Fig. 4, shows test curves of a steam turbine of this type, indicating the relation between speed and horsepower developed, also the steam rates per brake horsepower for different horsepowers and speeds. It will be seen on these test curves, with this particular turbine running at 3,800 revolutions per minute, that the steam rate is but 15 pounds per brake horsepower hour, as against 28 pounds when running at 1,400 revolutions per minute, or, if the turbine had to be slowed down to produce the highest efficiency of a direct-driven unit requiring the latter speed, it would use almost twice as much steam.

It is evident, therefore, that suitable gears, which absorb at the most less than 2 percent of the power in friction, can make an immense saving. Looking at the question the other way, the turbine, while developing 200 horsepower at 3,800 revolutions per minute, develops hardly more than 100 horsepower at the slower speed.

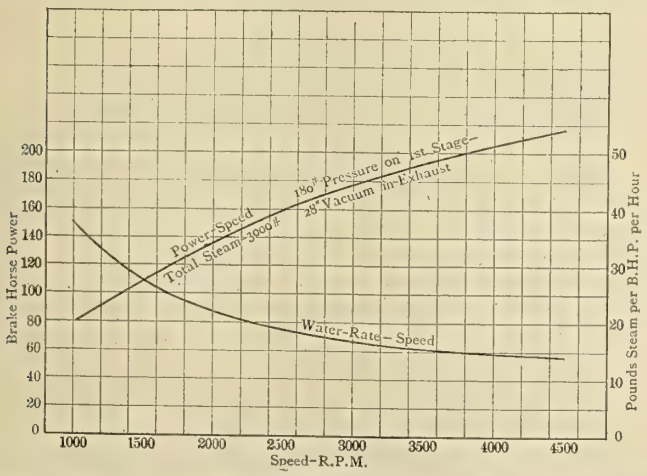


Fig. 4.—Test Curves Showing Relation Between Speed and Horsepower of Turbine

It is claimed that the geared units have had such a thorough trial and have met with such splendid success that, under many conditions, the geared type for driving pumps is most desirable, and also for belt driving from high- or low-pressure turbines. Low-speed, turbine-driven pump units receiving their power through gears are not subject to the detrimental speed compromise characteristic of the direct-driven unit. In municipal and steel mill pumping service the best steam consumption per water horsepower; that is, good duty per 1,000 pounds of dry steam, is essential, and the only way this can be obtained with a turbine is through reduction gears.

In one case where a duty of 115,000,000 foot pounds of work per 1,000 pounds of dry steam, which is equivalent to a steam consumption of 17.8 pounds per water horsepower, was obtainable from a geared turbine, but a direct-connected unit would have produced only 87,000,000 foot pounds maximum or a steam consumption of 25 pounds per water horsepower. As another instance, an 8,000,000-gallon-per-day, gear-driven turbine pump runs at 1,200 revolutions per minute and the driving turbine at 3,600 revolutions per minute. The use of the gears here made it possible to obtain a steam consumption of practically 22 pounds per water horsepower with 27 inches of vacuum, while with a direct-connected unit the steam rate would have been about 28 pounds.

German Ships Interned in United States Ports.—According to information compiled by the *Journal of Commerce,* 65 German vessels, aggregating 488,368 tons, and 12 Austrian vessels, aggregating 56,713 gross tons, are now interned at various American ports. Out of the total number of 65 German ships, no less than 28 with an aggregate gross tonnage of 304,545 are at the port of New York, 8 at Honolulu, 7 at Boston, 3 at Baltimore, 3 at New Orleans, 2 at Philadelphia, and the balance scattered among various other ports.

Calculations for Ship's Forms*

Discussion of the Theory of Rolling of Ships —Practical Results From Model Experiments

BY REAR ADMIRAL D. W. TAYLOR †

The matter of rolling is thrust upon the attention of all who have to do with ships. Of late years there has been a recrudescence of interest in this important subject, and the investigations made of it, instead of being of academic interest only, as had mainly been the case formerly, are of great practical interest and value. Model experiments have been resorted to in case of Russo's Navipendulum[2] and with the apparatus devised originally by Biles.[3] Schlick ‡ some years ago and Sperry § more recently have actually checked rolling by gyroscopes, and Frahm ** water tanks for the same purpose have recently been brought forward and installed in a number of vessels.

Those who investigate the literature on the subject will find little or nothing of practical value before the wonderful paper contributed by William Froude to the Institution of Naval Architects in 1861.††

In this paper, Froude laid down the underlying principles affecting rolling, particularly unresisted rolling, and, although there were soon other workers in this field, it may be said that the theory of rolling, as accepted to-day, is practically the theory developed by William Froude in his paper of 1861 and in his later writings on the subject. Perhaps the most important practical result of Froude's early work was the demonstration of the fact that if we wish to reduce rolling, particularly in large ships, we should reduce the metacentric height and lengthen the period of the ship. Formerly it had been generally thought that the greater the stability the less the rolling. Froude assumed at first that a ship broadside to regular waves of uniform period tended, at any instant, to set herself perpendicular to the disturbed water surface, and that the amount of this tendency was measured by the angle between the actual position of the mast of the ship and the normal to the wave surface. Subsequently he substituted for the wave surface what he called the "effective" wave surface, which he took to be the surface of equal pressure passing through the center of buoyancy of the ship. The voluminous work of Froude and his successors on the theory of rolling in the trough of a wave may almost be summarized in a single equation, which is a modified form of an equation given by Lloyd Woollard, Esq.,[4] in a paper before the summer meeting of the Institution of Naval Architects in 1913.

Let θ denote the angle of inclination of the vessel at any time, t, measured in seconds from an arbitrary time of starting, or zero of time. Let P denote the natural period of unresisted rolling of the ship in still water, which is expressed with close approximation by the formula

$$P \frac{2\pi\rho}{\sqrt{gm}},$$

where ρ is the radius of gyration of the vessel about its center of gravity, m is the metacentric height and g is the acceleration due to gravity. P is the complete or cyclic period of the double roll. Let P_w denote the natural period of the wave. Let e be the base of hyperbolic logarithms. Let a be the maximum slope of the wave affecting the ship—not the surface slope, but the virtual slope. Let C be the coefficient of resistance to rolling of the ship, the resistance being assumed to vary as the first power of the angular velocity, and let B and β be arbitrary coefficients depending upon the initial circumstances of motion. Then we have

$$\theta = Be^{-C\frac{2\pi t}{P}} \sin\left\{\frac{2\pi t}{P}\sqrt{1-C^2}+\beta\right\} + a\frac{P_w^2}{\sqrt{(P^2-P_w^2)^2+4C^2P^2P_w^2}} \sin\left(\frac{2\pi t}{P_w}-\tan^{-1}\frac{2CPP_w}{P_w^2-P^2}\right)$$

When $a = O$ and C has a value, or there is resistance to rolling, we have the case of resisted rolling in still water, which, as is obvious from the equation, is soon extinguished. When a has a value and $C = O$, the rolling is unresisted in uniform waves. In this case

$$e^{-C\frac{2\pi t}{P}}$$

is equal to unity and θ is the result of two superposed rolls, one a free roll, so called, of maximum amplitude, B, and period P, and the other a forced roll of maximum amplitude

$$a\frac{P_w^2}{P^2-P_w^2}$$

and period P_w, or the *period of the wave.*

In practice, C is quite small, but not negligible, so we would expect to find a ship in the trough of the sea soon rolling in the period of the wave, as prescribed by the second term. The formula was deduced upon the assumption that resistance to rolling varies as the first power of the angular velocity of rolling. While this assumption may be justified, if we properly choose C and deal with small rolling only, it is far from being exact. More than forty years ago there was an extended discussion on this question betwen Mr. William Froude and M. Emile Bertin, in *Naval Science* and elsewhere. Mr. Froude maintained that resistance to rolling was properly expressed by two terms, one, the more important, varying as the first power, and the other as the square of the angular velocity of rolling. M. Bertin stoutly maintained then, and to this day, that

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* From a paper presented at the International Engineering Congress, San Francisco, Cal., September, 1915. (For previous installments see October, 1915, and February, 1916, issues.)

† Chief Constructor, United States Navy.

2 "An Experimental Method of Ascertaining the Rolling of Ships on Waves," Captain G. Russo, Transactions of the Institution of Naval Architects, 1900.

3 "Experimental Determination of the Effect of Internal Loose Water upon the Rolling of a Ship Amongst a Regular Series of Waves," A. Cannon, Transactions of the Institution of Naval Architects, 1913, Part II.

‡ "Experiments with Dr. Schlick's Gyroscopic Apparatus for Steadying Ships," Sir Wm. H. White, Transactions of the Institution of Naval Architects, 1907.

§ "Active Type of Stabilizing Gyro," E. A. Sperry, Transactions of the Society of Naval Architects and Marine Engineers, 1912.

** "Neuartige Schlingertanks zur Abdampfung von Schiffsrollbewegungen und ihre erfolgreiche Anwendung in der Praxis," H. Frahm, Jahrbuch der Schiffbautechnischen Gesellschaft, 1911.

†† "The Rolling of Ships," William Froude, Transactions of the Institution of Naval Architects, 1861.

4 "The Effect of Water Chambers on the Rolling of Ships," Lloyd Woollard, Transactions of the Institution of Naval Architects, 1913, Part II

resistance to rolling should vary as the square of the angular velocity. I will give later results of some model investigations in this connection, but perhaps for the reason that C is small compared with the other quantities involved, the above expression for forced roll, regardless of the original assumption involved, is undoubtedly practically exact under the circumstances assumed, of uniformity of sea and known effective slope.

If we take a pendulum mounted so as to have resistance to oscillation and give it harmonic impulses of a period different from its natural period, and of strength corresponding to an angle a in the formula, the pendulum very soon sets up forced oscillations of the period of the impulses, and until the resistance to the motion of the pendulum is relatively much greater than the resistance to rolling of a ship, the amplitude of these uniform forced oscillations will be almost exactly that derived from the formula above.

The formula has also been checked as to period by a number of experiments with models in uniform waves at the United States Model Basin. It is remarkable how models, whether with or without bilge keels, when in the trough of a series of uniform waves, will promptly fall into step and oscillate in consonance with waves whose periods vary from ¼ to 1½ times the natural period of the model. That there is a practical limit to this, however, is indicated by model experiments. For instance, a wave whose period is only from ¼ to ½ the natural period of the ship will not induce forced rolling in the latter unless it has a certain height. Waves that are low as well as short have little or no effect, as might be expected.

Since experiment confirms so fully the formula above, it might seem at first sight that it is, in theory, a complete solution of rolling problems. As a matter of fact, it is far from this, for the simple reason that it assumes uniform isochronous known impulses from the waves. While the sea has infinite variety and will at times give uniform isochronous impulses, this is a rare occurrence. In an ordinary sea, successive waves vary materially in height and period. The net result is that the free-rolling term in the formula does not disappear. We may express this result in *quasi* mathematical fashion by saying that, instead of measuring t from one initial condition, we are constantly taking a fresh start, and that with each fresh start, B, β, a and P_w are changed in an unknown manner to suit the initial conditions.

Fig. 1 is an actual rolling record from a large battleship in a rough sea, and is fairly typical of the usual rolling of a large ship. The irregularity of the rolling is obvious upon inspection. We note in Fig. 1, as the most conspicuous feature, that periods of maximum rolling alternate with periods of comparative quiescence. This is typical of theoretical, unresisted rolling in a series of waves whose period differs from the period of the ship, but, in the latter case, the alternations as shown by the formula are systematic and regular, while in actual rolling they are neither. If we could estimate accurately the forced rolling of a given ship in a given uniform sea we could be certain that the maximum angle of actual roll would not be as much as twice the angle of forced roll. For if we had the ship in step with the sea and doing forced rolling, the worst that could happen would be for the phase of the sea to suddenly shift, so that the forced roll became a free roll and a new forced roll of the same amount would grow up, being superposed upon the decreasing free roll. Evidently the combination of the decreasing free roll and increasing forced roll could never exceed the maximum forced roll.

Unfortunately, as to one of the most important factors in the forced-rolling term—namely, a—we have very little real knowledge. Froude started with the natural assumption that a was the maximum surface slope of the wave. He soon found, however, that, in practice, ships and models did not roll so much as would follow from this assumption, and consequently took for a the maximum slope of the surface of equal pressure at the depth of the center of buoyancy below the surface. There are some indications in Froude's latest writings on this subject that he regards even this reduced value of a as perhaps too large. The matter is one of much practical importance for several reasons:

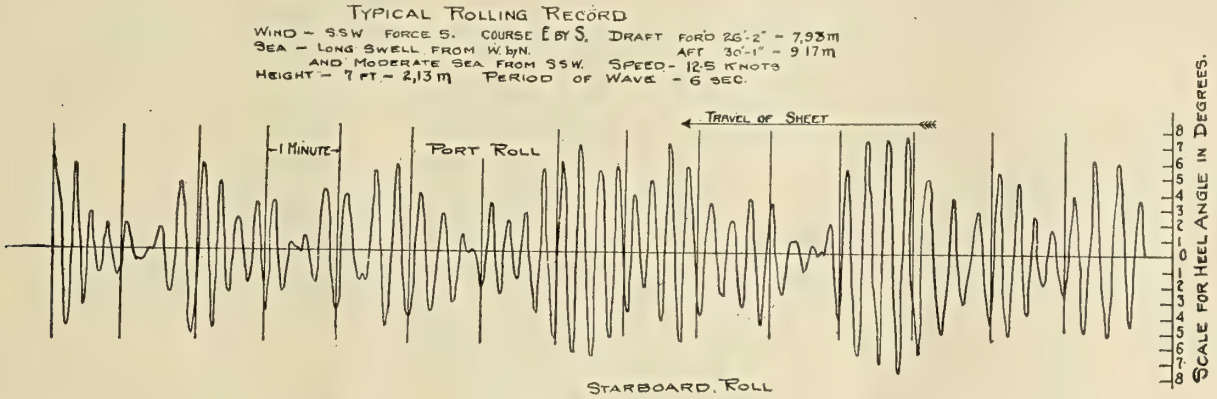


Fig. 1

1. Heavy rolling of ships is always mainly forced rolling. When there is approximate synchronism of the wave impulses with the natural period of the ship, she approaches rapidly the maximum forced roll, which, neglecting resistance, is

$$a \frac{P_w^2}{P^2 - P_w^2}.$$

The greater the natural value of a the more rapidly the roll grows, and the greater the range of wave period over which dangerous rolling may be set up.

2. In practice, when there is approximate synchronism, ships would promptly capsize in a regular sea were it not for the fact that the natural increment of roll due to the passage of a wave is neutralized by the natural decrement of roll due to the resistance of the ship to rolling while the wave passes. The greater the value of a the greater the rolling angle to produce an equal decrement.

3. When one undertakes to stop rolling by a gyroscopic or other mechanical device it is very desirable to know how much roll a given wave will communicate to a given

ship. Only when this is known do we know how much of a sea we have provided against with our apparatus.

It might seem at first sight as if observations of rolling on actual ships would give the information desired. While extensive observations of this nature would be of much help (they seem very difficult to obtain and are painfully rare), they would not fully meet the need, for the reason that increment of roll due to the passage of a given wave might, in the case of a rolling ship, be very much greater or very much less than if the ship had been originally upright at rest. It is the increment in the latter condition that we need to know in connection with apparatus to hold the ship upright.

Some investigations at the United States Model Basin, of the rolling of models, while not conclusive, indicate strongly the need for developing the theory of rolling beyond the condition in which it was left by Froude. Such model investigations are by no means easy. One great difficulty is in connection with the waves. It is, of course, easy to produce waves of uniform length, but waves advancing in a canal of limited width, although looking very uniform to the eye, when carefully investigated seem to vary in height in a very puzzling fashion. The model experiments referred to seem to indicate that not only the metacentric height, but the absolute height of the center of gravity influenced the rolling behavior.

This is upon consideration just what might be expected. Consider a ship in the trough of the sea. She is acted upon by the reactions of the water which may be regarded as an infinite number of transverse forces. These can be reduced to a single resultant, and we know from the elementary principles of mechanics that the center of gravity will move as if the resultant were exerted through it, while there will be a movement of rotation due to the leverage of the resultant about the center of gravity. This is altogether independent of any question of metacentric height. We know as a matter of fact that under such circumstances the center of gravity of the ship has an orbital motion. Fig. 2 gives actual paths of the center of gravity of a model 20 feet by 3.436 feet by 0.970 foot by 2,500 pounds displacement in waves of the length and height indicated. These orbits are elliptical, probably because the waves are of the shallow-water type when the water particles traverse elliptical orbits. For deep-water waves the orbits would have been nearly circular. From the orbital path it would be possible to deduce the acceleration at any point and hence the corresponding forces. Also, if the angular motion were carefully determined, we could, by analysis, deduce the positions or lines of action of the resultant forces. While experiments hitherto made are not of such order of accuracy as to allow this to be done, it may be pointed out that the orbital path of the center of gravity in deep-water waves is roughly circular, indicating that the actual resultant unbalanced forces are harmonic in their nature. If we take a vessel at the steepest part of the wave, when she is moving vertically in her orbit, the acceleration of the center of gravity is horizontal, so that if the ship is vertical at the instant, the resultant force acting upon her is horizontal.

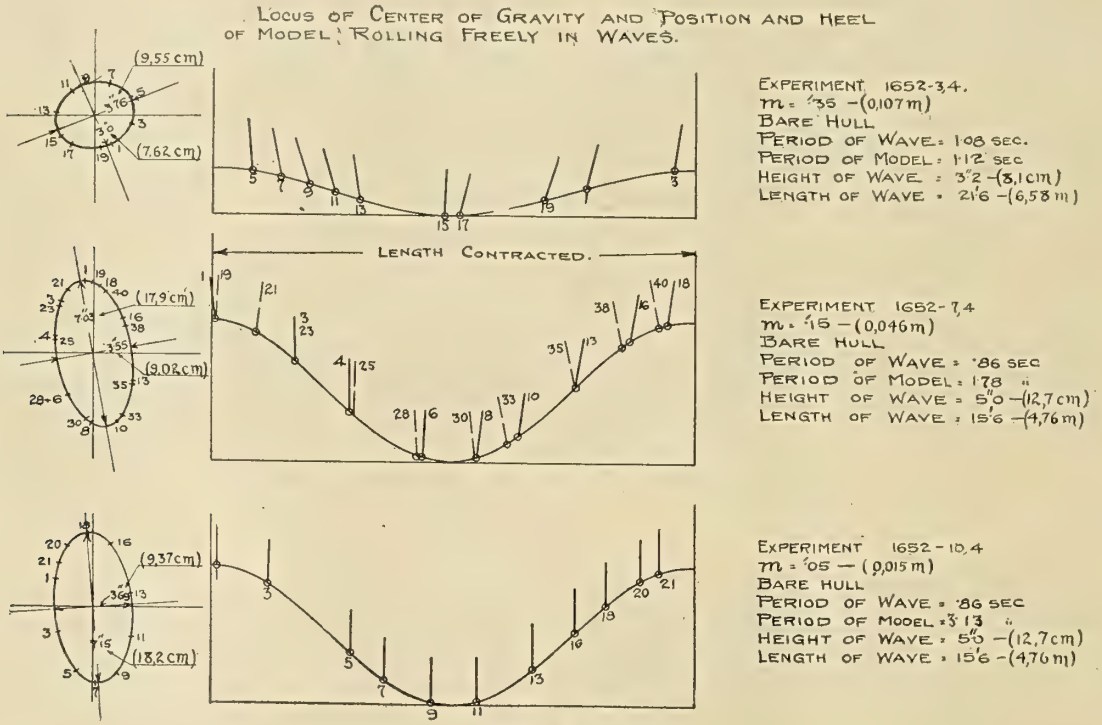


Fig. 2

If this resultant force should pass below the center of gravity, instead of above, the ship would actually tend to roll toward the wave instead of away from it. In practice it would seem that for most ships the resultant is not far from the metacenter. Froude's theory seems virtually to assume that the resultant passes always through the metacenter. It is quite possible, however, that, particularly when the ship is specially shaped with this in view, the resultant will really pass below the metacenter. This would account for the fact that reduction in metacentric height appears often to reduce rolling more than can be accounted for by the change in metacentric height alone.

It is not likely that the actual wave forces upon a ship have a single point through which they pass. The resultant force will cut the axis at varying distances above the center of gravity as a wave passes, and there will also be variations in this respect as the waves vary and as the ship rolls. But it is obvious that the closer to the center of gravity the line of the resultant force due to a wave, the less the rolling, and that this fact should not be ignored in shaping vessels.

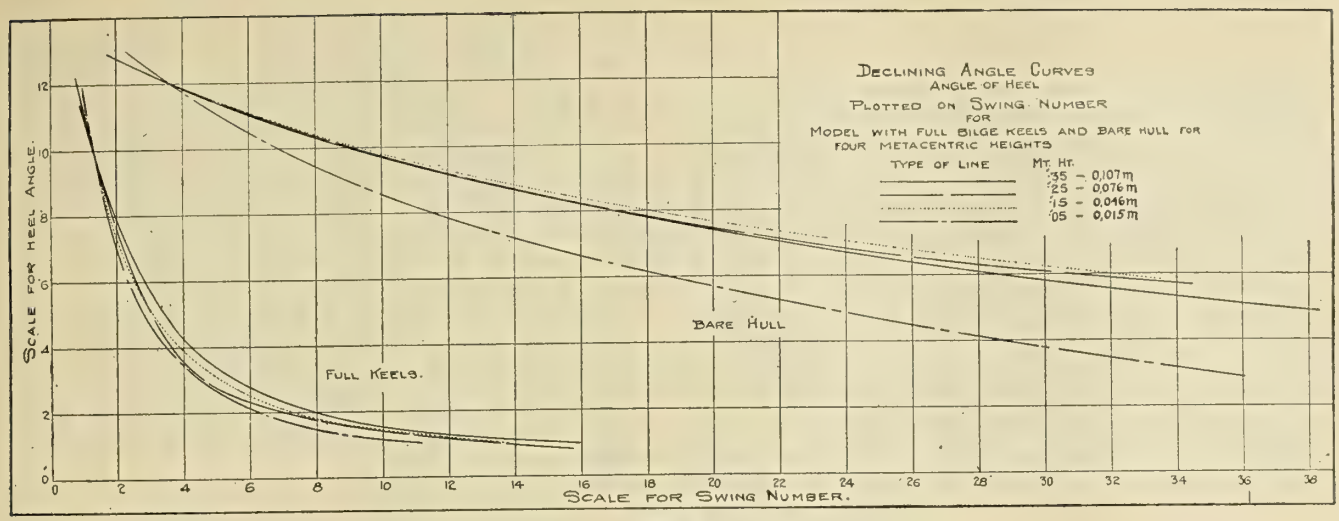


Fig. 3

In Fig. 2 we see that as the metacentric height of the model is reduced from 0.35 foot to 0.05 foot the rolling is markedly reduced, the model in the latter case remaining practically upright, though the center of gravity describes an elliptical path which shows a considerable bodily motion of the model. In this case it appears that the resultant of the external forces acted very close to the center of gravity and the metacenter.

The diagram for the 0.15-foot metacentric height refers to a somewhat disquieting occurrence. The natural period of the ship was about twice that of the wave, and there is rather heavy rolling in the natural period. Large ships are much more likely to encounter steep waves of half their period than of their full period, and if half-period waves can produce rolling effects similar to those of synchronous waves, dangerous rolling is apt to be caused by them. But even with the accurate adjustment possible with artificial waves, this heavy rolling from half-period waves was not easily produced; so with the nearly always irregular waves of the sea, the danger of heavy rolling from half-period waves is probably remote. Still it exists.

I have referred already to the difference of opinion between Mr. Froude and M. Bertin as to the power of the angular velocity with which the resistance of the ship to rolling in still water varies. For such rolling a large number of accurate declining-angle curves of models have been obtained at the United States Model Basin, usually from an angle of 15 degrees or so; and these have been analyzed. It was found that the nature of these declining-angle curves was such that they did not satisfactorily agree with either Froude's theory or Bertin's theory. Any particular curve could, however, be represented quite well, and many of them almost exactly, on the assumption that the resistance to rolling at any instant varied as a coefficient into some fractional power of the angular velocity. Unfortunately, this fractional power varied somewhat inconsistently, although in many cases it seems to be very close to 1.5. The limits, however, appear to be fairly well defined. In no case tested did the resistance to rolling vary as a power of the angular velocity greater than 2 or less than 1. When rolling in still water, the center about which the ship revolves is, in practically every case, between the center of gravity and the waterline; that is, when the center of gravity is below the waterline, this center was above the center of gravity, and when the center of gravity was above the waterline this quiescent center was below the center of gravity. It did not appear, however, that this center remained in quite the same position throughout the roll.

We know in theory that for unresisted rolling in still water the period is given by the following formula:

$$P = \frac{2\pi\rho}{\sqrt{gm}}$$

where P is the complete or cyclic period of roll in seconds, ρ is the radius of gyration of the vessel about its center of gravity, m is metacentric height, and g is acceleration due to gravity.

For ordinary ships, although we frequently know the metacentric height, the radius of gyration is not known, so the formula is not of much practical value; but it is more or less used, in practice, to arrive at the radius of gyration from observations of the rolling period in still water. But, since actual rolling is resisted, there is some question as to the accuracy of the values of ρ so determined.

A number of the models tried at the Experimental Model Basin were carefully weighted and inclined in order to determine their metacentric height, and also swung in a hanging cradle in order to enable their radii of gyration, as weighted, to be determined. The dimensions of three of these models are as follows:

Model Number	Length, Feet	Breadth at L.W.L. Feet	Draft, Feet	Displacement, Pounds	Transverse Metacenter, Feet
1650.....	20.0	2.926	1.139	2,500	at L.W.L.
1651.....	20.0	3.193	1.044	2,500	0.2 ft. above L.W.L.
1652.....	20.0	3.436	0.970	2,500	0.4 ft. above L.W.L.

Each model was tried with exceptionally large keels, 1.8 inches, or some 15 percent of the draft, in depth, and 10 feet long on each side; also, with the middle third of the keels removed, and with all of the bilge-keels removed. Four metacentric heights were used, ranging from a very small metacentric height of 0.044, the draft of the vessel, to a very large one of about 0.36 of the draft. In the following table will be found the theoretical period of unresisted swing of each model in each condition, calculated from the formula at the top of the next page.

TIME IN SECONDS FOR ONE SWING OR ½ PERIOD

Model No.	Bilge Keels	1650 Observed	1650 Calculated	1651 Observed	1651 Calculated	1652 Observed	1652 Calculated
GM—0.35 feet.	Full	.94		1.12		1.17	
	⅓ off	.95	.954	1.10	1.040	1.15	1.100
	none	.94		1.05		1.12	
GM—0.25 feet.	full	1.21		1.36		1.41	
	⅓ off	1.18	1.130	1.34	1.274	1.41	1.338
	none	1.16		1.29		1.34	
GM—0.15 feet.	full	1.63		1.78		1.87	
	⅓ off	1.61	1.505	1.75	1.678	1.86	1.763
	none	1.53		1.67		1.79	
GM—0.05 feet.	full	2.94		3.27		3.36	
	⅓ off	2.89	2.740	3.20	2.996	3.33	3.083
	none	2.83		2.96		3.13	

$$\frac{P}{2} = \frac{\pi \rho}{\sqrt{gm}},$$

and the actual swing period as observed in careful rolling trials in still water.

It will be seen that the actual periods are remarkably close to the theoretical periods, and that the effect of the excessively large bilge keels upon the period is not great. It would seem, then, that we could rely upon the radii of gyration of actual ships, as determined by rolling experiments, with a good deal of confidence.

Incidentally, it is interesting to note that the declining-angle curves varied remarkably little with metacentric height. Thus, Fig. 3 shows eight declining-angle curves for model No. 1652, four being with bare hull and metacentric heights ranging from 0.05 foot to 0.35 foot, and the other four being with full bilge-keels and the same metacentric heights. It should be remembered that these declining-angle curves are plotted upon roll numbers and not upon time. The vessel of large metacentric height, rolling more quickly than the vessel of small metacentric height, would have a given roll extinguished in less time, but it would take about the same number of rolls as for the vessel of small metacentric height.

Voltaic Corrosion and Prevention

BY THOMAS J. ROGERS

Numerous methods have been suggested and employed for the protection of those parts of a ship's fittings which come in contact with sea water, among which zinc has been extensively used for this purpose from its electro-positive character. The influence of this metal in protecting another which is negative to it and under the salt solution, is a subject that has occupied the attention of practical men for a long time. It is one of very great importance at the present time, as corrosion takes place to an alarming extent on those fittings which have to conduct sea water to the various points in the modern steamship. To protect these fittings, many experiments have been tried, and no appreciable results have been obtained. The highest engineering skill has been employed, but nevertheless there seems to be a great deficiency in the knowledge of the extent of this influence and how and when it is most effective. The frequent corrosion of condenser tubes, of the pipes used as salt water conductors and of the sundry fittings which comprise the salt water system of the modern "leviathan of the deep," is abundant proof of this deficiency, either in the manner of application or in the method employed.

From a careful observation of salt water pipes which have been repaired or renewed under the author's supervision, he is convinced that the excessive pitting is due to a gas, or a combination of gases, and that wherever a zinc plate or ring has been placed in the neighborhood of these fittings to prevent galvanic action, the pipes are always severely pitted at the top part of the inner surface as they are placed in the ship, and that their length of service is very short in comparison to those which have not been placed under the influence of this metal, as in the manner herein described.

The method employed to prevent galvanic action to plating of hull adjacent to the openings of sea valves is to fit a cast zinc ring in the apertures of supply and discharge pipes below the water line. This arrangement under the most favorable conditions is only a partial protection, which will induce a more negative state to the metals in proximity of the zinc and render those parts farther distant more positive. Such a diversity of conditions will give rise to voltaic action between the extremities, and from this inequality of protection it is productive of numerous evils which, when arising in one locality, may become contagious and affect the whole surface exposed to this influence. It can be readily imagined that the zinc ring has, from the manner in which it is secured, a metallic contact with the lip of the composition stool which pierces the hull. A pair of metals so arranged will not be able to generate much current and the conditions are such that it is not applicable for the purposes for which it is intended, as the conducting powers of the composition and copper connections are so much superior to the salt water and the plating of the hull that whatever of current is excited will find the easiest passage through the fittings, and as there is no electric effort in the direction of the plating, it being a positive metal in this series, will be given a more positive value in the solution.

It is a well-known fact to electro-chemists that when copper and zinc or composition, and copper and steel and zinc, as in this case, are placed in a salt solution, they form a single fluid battery with two parts of metals, and no battery of this order will generate or maintain an electric current of a uniform constancy of strength to protect the metal from dissolution by galvanic action, as the surfaces of the positive metals soon become decomposed in their order and the negative metals, by becoming polarized from the gradual accumulation of hydrogen gas upon their surfaces, become insulated and give a counter effect in the solution.

In applying this principle as a means of protection there are other elements which have not been taken into consideration. There are possibilities of the electro-chemical action at these points setting free many elements contained in sea water which are injurious to a ship's fittings. In the action between the sea water and the metals hydrogen gas is evolved. This gas alone is harmless, but there are cases in which it enters into combintion with other elements and dissolves those metals which have an affinity for it. Hydrogen, when in the act of being evolved by the agency of a metal, manifests sufficient activity to decompose other existing combinations present in the water and appropriate their elements, thus forming new compounds. It is well known to chemists that when a current of electricity is passed through a salt solution the salt contained in the solution will become decomposed, caustic soda being set free from one point, and chlorine from the other point, of the terminals. Chlorine alone acts with great energy upon most substances, disintegrating them and forming new compounds. It has a chemical affinity for hydrogen gas, and under favorable conditions will combine and form one of the greatest solvents known.

From the location of the apertures in the hull of a vessel, and the specific gravity of these gases, they are compelled to arise and pass through the system of pipes when the valves are open, and when closed to escape to the surface water along the outer skin of the hull. From the great tenuity of these gases they have a great penetrative or rapid diffusive power; many metals are penetrated through their pores, and when there is an adhesive attraction or a feeble chemical affinity between them and the metal, they will condense on its surface or in its pores. Eventually these gases find their way into the boilers through the feed pumps which have sea connections through the salt water "make-up" at the condensers, or through the packing of tubes in condenser heads, which it is very difficult to keep perfectly tight, and which in some cases are even allowed to leak to make up the deficiency of feed water. By this questionable method of engineering considerable of this gas finds its way into the condensers, the bubbles of gas in traveling

along with the circulating water through the tubes, becoming trapped in the ferrules, and with the assistance of the vacuum on the steam side and the pressure of the circulating water on the other, it is forced into the condenser, carried down with the condensed vapor, and dissolved into the feed water. From the continual inflow of this gas, the feed water becomes highly charged with it, and those metals in the circuit for which these gases have a liking are readily disintegrated. Copper in its free state is a preventative of crustacean or other marine growth, but under existing circumstances, from the increased negativeness of the fittings in proximity of the zinc, they grow abundantly upon the inner surface of the fittings for a distance of six feet from the aperture and to such an extent as to reduce the area considerably. Beyond this zone of marine growth corrosion of the copper connection commences and continues throughout the system as far as the gases reach, and the greater the distance from the zinc the coarser is the pitting, demonstrating that one point is protected at the expense of another.

The author has seen some specimens of corroded copper tube selected promiscuously from a defective salt water system, and cut open at the bottom of the pipe to show the extent of the corrosion from the gases which traveled along with the water. The bottom and sides of this system of pipes were free from pits and showed a uniform wear from the friction of the water and the action of the salt, but were good for several years' service, although the extent of the corrosion made it economical to renew the sections so affected. The length of service of these fittings was nine months, but with the thickness of metal used it should, under fair conditions, have given at least the same number of years' service. This corrosion is often attributed to imperfections in the metals, but allowing such to be the case, it is impossible for a mechanic in making and installing a system of pipes to get the imperfect parts of a tube, or sheet from which the pipe may be made, always at the top.

If the practice of placing zinc rings in the openings before referred to, as a means of preventing galvanic action at these points, is continued it might be advisable to fit gas chambers on the top parts of connecting pipes at, or as near as possible to, the sea valve to trap the gases as they are evolved, and lead small pipes from the tops of the chambers to and through the hull above the waterline to release them. Similar pipes should also be led from the top of both ends of the condensers to release the gas trapped in the covers, which will thus also insure a solid flow of circulating water and improve the efficiency of the condensers. The composition fittings which pierce the hull below the waterline might be coated with an enamel paint or porcelain that is impervious to sea water, so that when the sea valves are closed there will be no action between these fittings and the plating of the hull.

Important Development in Life Saving Equipment.—The recent approval by the United States Steamboat Inspection Service of the new universal Ilanasilk types of life preservers, invented by Lieutenant S. P. Edmonds, United States Coast Guard, retired, of Newark, N. J., marks an important event in the development of life saving equipment for use on vessels of all kinds. These life preservers were officially adopted by the United States Navy about two years ago after extensive tests and demonstrations of efficiency in actual use on naval vessels. They have also been adopted by the British and Canadian governments for all types of vessels. The equipment includes ship life preservers, pillow life preservers, safety mattresses, boat cushions and swimming floats.

The American Bureau of Shipping

One of the most vital questions affecting the future growth of the American merchant marine and shipbuilding industries is the maintenance of an influential, independent American classification society for merchant vessels. That this question is being brought to a successful issue is shown by the complete reorganization of the American Bureau of Shipping under the guidance of Mr. Stevenson Taylor, president of the American Society of Naval Architects and Marine Engineers, who has recently been elected president of the Bureau of Shipping. Through his efforts and the universal support accorded to him by the various American shipping interests, the American Bureau of Shipping is now well on its way to become a highly efficient technical organization which not only can be used to focus the opinions and aims of those directly interested in mercantile tonnage, but also will command the respect both at home and abroad due to the American merchant marine.

Hitherto the major portion of the classification of American tonnage has been carried out by local representatives of foreign classification societies. Lloyd's Register of Shipping, the premier classification society in Great Britain, which has shared extensively in this work, has only recently been endeavoring to form a separate committee in the United States. Such a combination, however, it is believed, could not be truly international, but would be essentially a British organization with local representation, as the actual control of the classification work of Lloyd's, including the rules for shipbuilding, the appointment of surveyors and the organization in the United States, would still rest in the hands of Lloyd's Central Committee in London, all of which is clearly defined in the society's regulations governing such a committee. Furthermore, such a step would mean that characters assigned to vessels by an American committee of Lloyd's would have to conform or would be subject to alteration by the society's general committee in London. Certificates of classification could not be issued by any local committee.

Opposition to such a local committee of a foreign classification society in the United States indicates a pronounced national feeling on the part of the various American shipbuilding and shipping interests, and it is felt that there will be no difficulty in maintaining a highly efficient classification society wholly American in character and standing. The true interpretation of international classification must necessarily mean national societies working under an international agreement rather than a foreign society with local national representation.

The lack of a national classification society will inevitably lead to government control in the design and construction of vessels, and it is generally felt that such control is not desirable, in that it may be arbitrary and tend to check enterprise and mechanical and commercial progress. Other maritime countries have their departmental bureaus, such as the Board of Trade in Great Britain, the See-Berufgenossenschaft in Germany, and others, but in these instances the actual control, so far as affecting the construction of vessels is concerned, is in effect left in the hands of the national classification societies, who also are empowered by their representative governments to carry out the requirements of loadline regulations. These societies have won the respect of their national legislative bodies as far as their merchant shipping is concerned, and the legislative bodies of these countries are largely guided by the advice and experience of these national societies. With active control representative of the underwriting, shipowning and shipbuilding interests of the United

States, and with a technical staff which has inspired the confidence of these interests, the American Bureau of Shipping will be in a position to place its claims before the United States government for national recognition.

The appointment of Mr. Norman E. McClelland as chief surveyor of the American Bureau of Shipping marks an important advance to meet this strong and insistent demand for an American classification society which shall be organized and administered on broad lines of efficient progressive business and technical ability. Mr. McClelland was born in 1876 and received his early training as a naval architect in the shipyard of Harland & Wolf, Belfast, Ireland, where he passed through the various departments in the yard and completed a five-years' apprenticeship in the drawing office. A few months after completing his apprenticeship, Mr. McClelland was appointed manager of the company's north yard, and for some years was associated in the construction of the famous White Star and other large transatlantic liners built by this firm. In 1899 Mr. McClelland was appointed a Lloyd's surveyor and shortly afterwards came to the United States. He was afterwards transferred to Glasgow and subsequently to Antwerp, and during the ten years spent at these important shipping centers gained a wide experience in mercantile shipbuilding, marine engineering, steel making and ship repairing.

After a most successful career in Antwerp, Mr. McClelland was transferred to Lloyd's head office in London and was promoted to the chief surveyor's staff. In this capacity he traveled extensively in Europe and was entrusted by Lloyd's to carry out various important negotiations. In 1912 he was appointed to Lloyd's New York office and empowered to deal with the plans of vessels submitted for Lloyd's classification by shipbuilders and shipowners in the United States. In his position as principal surveyor Mr. McClelland also co-operated with Mr. James Mancor, Lloyd's principal surveyor for the United States and Canada, in supervising the general surveying duties in this country. He is, therefore, accustomed to dealing with both the technical and practical aspect of questions relating to new construction and ship repair, having an intimate and detailed knowledge of shipbuilding methods and practice in the United States and being familiar with the various shipbuilding and steel making plants in this country.

Mr. McClelland is a man of strong personality and the American Bureau of Shipping is to be congratulated upon having secured as its chief surveyor one whose appointment has received the uniform approbation of the various shipping interests in this country.

A further valuable addition to the technical staff of the American Bureau is the appointment of Mr. James W. Lee, formerly of Baltimore, Md., well known as a naval architect with long experience in the United States Navy Department and the Revenue Cutter Service, as well as the manager of a large shipbuilding plant in Baltimore. Mr. Lee took charge of the office of the Bureau at Newport News, Va., on April 15 and will cover also the Norfolk district.

Another appointment recently made is that of Mr. Joseph E. Borden as head of the Philadelphia office of the Bureau. Mr. Borden's appointment became effective on May 1.

Other appointments are under consideration and will be determined as rapidly as possible. Meanwhile the vitally important work of revising the Bureau's Classification Rules and Regulations will be undertaken, so that they will represent the most advanced requirements for modern safe ship construction.

Utility of Exhaust Steam in a Shipyard

Speaking in a general way, it can fairly be said that the power generating methods of industrial plants have relatively stood still while central station and marine practice has been forging ahead. By means of the steam turbine, the high vacuum condenser, improved boiler room practice and similar expedients, fuel costs in large power stations have been reduced to a minimum. Large numbers of industrial plants have, on the other hand, been loath to discard machinery as yet unimpaired and are still operating reciprocating engines of only moderate steam economy, non-condensing or with low vacua. However, by introducing a low-pressure turbine, many of these plants could greatly reduce fuel bills while retaining to good advantage their present equipment.

As an example, the shipyard of the Newport News Shipbuilding & Dry Dock Company, of Newport News, Va., was formerly supplied with electric power by three McIntosh & Seymour engine-driven generating sets of 600 kilowatts each, one of which was operated continuously for carrying the yard load, while the other two were used only when pumping out dry docks. The demand for power increasing, it was found upon investigation that sufficient exhaust steam could be obtained from the four air compressors and four hydraulic pumps in use in the yard to operate a 1400-kilowatt low-pressure turbine. This would be more than sufficient for carrying the yard load, while the reciprocating units could be retained as spares, to be used only when pumping out dry docks.

Because of its much greater simplicity, less cost for the complete equipment and high overall efficiency, a gear-driven direct current generator was selected and installed. This unit consists of a DeLaval low-pressure turbine, operating at 3,000 revolutions per minute, driving two 700 kilowatt Crocker-Wheeler direct-current dynamos at 500 revolutions per minute. The turbine is of the pressure stage type and receives the exhaust from air compressors and hydraulic pumps at a pressure of about 1 pound gage, exhausting to a surface condenser having 7,015 square feet of cooling surface and served by a rotative dry vacuum pump and a two-stage, turbine-driven hot well pump. A second surface condenser in the same power house can be connected up if necessary to take care of unusual loads.

The double generator arrangement results in an exceptionally neat arrangement for a unit of this capacity, as the pressures on the bearings and gear teeth are greatly reduced as compared with a single gear transmitting the same power, while the generators admit of series and parallel connection for two different voltages. It is also possible to operate one generator alone in case of accident to the other.

The normal yard load of about 1000 kilowatts at 220 volts is regularly carried by the turbine-driven generators, while when pumping out a dry dock the combined load of aproximately 2,300 kilowatts is carried by connecting one of the 600-kilowatt engine-driven generators in series, or, as a booster to the turbo-generators, thus supplying approximately 500 volts for the two large pump motors in the dock pump house. By varying the field of the engine-driven generator, which can be done by the attendant at the dock pump house, the pump load can be controlled. A small centrifugal pump, connected to the regular 220-volt circuit of the yard, is also installed for draining the dock.

While records of steam consumption are not available, the fact that an increased electrical load is now being carried by utilizing exhaust steam formerly wasted from air compressors and pumps indicates a large economy in fuel costs.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Laurenti Submarines

Referring to the statements regarding the Laurenti type of submarines made by Mr. Simon Lake, in his article on "Modern Submarines in War and Peace," on page 400 of the September (1915) issue of INTERNATIONAL MARINE ENGINEERING, the writer wishes to state that Mr. Lake proposed his type of submarine to the Italian navy in the year 1905. Minister Mirabello submitted the matter to a committee, and the members of the committee conferred with Mr. Lake, with the consequence that submarines of the Lake type were not purchased for the Italian navy.

The writer also takes exception to the statement which Mr. Lake attributes to Minister Mirabello and the committee regarding the deficiency of longitudinal stability in submarines of the Laurenti type. As a matter of fact, I believe I am correct in stating that Mr. Lake was in Rome in the summer of 1905, while the first submersible of my type, namely the *Glauco,* began her trials in a submerged condition on January of the year 1906, without, however, developing any deficiency in longitudinal stability to which Mr. Lake refers.

Submarines of my type are quite different from the Lake submarines, and hydroplanes of the Lake type have never been adopted on them. C. LAURENTI.

Spezia, Italy.

Economical Method of Removing Ice from the Deck and Rigging of a Vessel

Vessels navigating in the colder latitudes are often inconvenienced by being covered with ice and snow. For the proper working of the ship it is essential that this ice and snow be removed, particularly so in the case of vessels which remain permanently in this latitude, for too great an accumulation of ice might render the boat unstable, especially so in the case of small fishing vessels.

The task of removing ice from decks, rails, rigging, etc., is by no means an easy one. Some of the steam fishing vessels use a small hose with hot water, which is supplied by an injector, and the hot water cuts off the ice. This method is very effective and removes the ice and snow quickly and thoroughly, but it takes considerable hot water, and, of course, is an expensive way of doing it, for the steam must be furnished, in addition to that ordinarily used, causing an increase in coal bills. For the want of a better method it does very well.

The Coast Guard cutter *Seneca* encounters severe trouble from the accumulation of ice and snow on board when she goes on the ice patrol off Newfoundland, and the chief engineer has devised a very simple scheme whereby they can supply plenty of hot water without throwing away available heat units. This method can only be used when the ship is under way, which is generally the case at sea.

The circulating water discharge pipe has been tapped to receive a fairly large connection which leads to the deck service pump. This pump delivers a sufficient portion of the discharged circulating water through the mains to the deck hose, where it can be used in removing the ice. As the circulating water is discharged at a fairly high temperature, it furnishes plenty of heat to loosen the ice, and since this heat would ordinarily be thrown away, the hot water is furnished at no loss in economy. N.

New York.

The Drafting Room

The article on "The Drafting Room," by Chief Draftsman Robinson, in the January issue, was easily worth an entire year's subscription to the magazine to me, as it set forth exactly the principle for which I have always contended and tried to live up to during my twelve years as chief hull draftsman for the ———— Shipbuilding Company. For six years of this period I was naval architect, chief draftsman and checker combined (my work including ship calculations, steel orders and estimates on new work), with a short-handed and underpaid staff, and, in order to turn out the class of work I believed in, and, as advocated by Mr. Robinson, without proper assistants, I was obliged to work ten and a half hours per day four or five out of the six.

My work received considerable praise from the men who had to use the plans, especially in view of the general condition of this yard, but scarcely ever from the management, and then only from a few who could appreciate it.

At the time when the yard and staff were best organized and doing their best work we were badly handicapped in the office through lack of room, there being only one room available for the use of both the engineering and hull staff, an arrangement not conducive to efficiency in either. I and my leading man, who, by the way, was a first-class draftsman, had our quarters in a small attic apartment which had been fitted up for our use, the best accommodation our managers could provide under existing circumstances, and which was facetiously dubbed the "cock loft" by one of our Clyde men. This was reached by a small scuttle and companion ladder, to give it the proper "seafaring touch," and, as the latter was fully up to the requirements as regards steepness, the casualties among the men from falling down or butting their heads against the scuttle cover were rather high. We were the "goats," all right, and developed the characteristics from environment, as nobody but a billygoat could have withstood the range of temperature in this department—from 52 degrees in winter to 105 degrees in the good old summer time.

Finally there came a change in the management, and as it was on this subject of detail on the plans, in particular, on which we disagreed, I was obliged to quit their employ.

Subsequent observation and experience in this case, and in general, in view of the loss of time and money due to inaccurate and half-finished plans, have only strengthened my conviction that such articles as that by Mr. Robinson should tend to educate those in control of shipyards on this point, and indicate to them the probable source of some of the losses of which they so frequently complain.

P. W. K.

Analyzing a Marine Steam Plant*

The object of plant analysis is economy. Having outlined in the last issue the general methods used in making an economic analysis of a steam plant, the details will be taken up consecutively, with a view to looking into those broader economies, which show up on the books under reliability and well-kept schedules and safety, as well as the purely technical or thermal economies which are so dear to the student.

The first possibility of economy is in the purchase of fuel, the source of power. There are two phases of this branch of management: First, to obtain the greatest number of British thermal units per dollar expended; second, to find a coal suitable for the furnaces. An anthracite may have twice the calorific value of a certain bituminous coal, but it may cost more than twice as much. On the other hand, the bituminous coal may have so much clinker, or be so fine that it all goes through the grate bars, or it may take so long to clean fires that the ship cannot make schedule. These items will be taken up in detail.

All fuels are quite closely related. The coal of to-day was wood and plant life many ages ago, and the belief is quite general that the oil of to-day came from the fats and organic structure of a prolific animal and shellfish age. The writer does not pretend to pass upon these theories, but believes that they are quite generally accepted. Geologists have drawn up a table showing the various stages by which wood became coal, and all of these stages exist in the world to-day, and the processes are going on now, as follows:

Material	Carbon Percent	Hydrogen Percent	Oxygen Percent	Total Percent
Wood	49.10	6.30	44.60	100.00
In the course of ages the wood lost a certain percent, as follows	18.65	3.25	24.40	46.30
And became Lignite coal	30.45	3.05	20.20	53.70
This also lost weight	12.35	1.85	18.13	32.23
And became Bituminous coal	18.10	1.20	2.07	21.37
This lost	3.57	0.93	1.32	5.82
And became Anthracite coal	14.53	0.27	0.65	15.45
This lost	1.42	0.14	0.65	2.21
And became Graphite	13.11	0.13	0.00	13.24

In practice all conceivable intermediate grades exist; also, there is such an excellent market for pure graphite that it is made artificially, by electrolytic means. Bearing in mind the relation between the fuels as shown, we find their average calorific values as follows:

Wood, 6,000 B. T. U. for soft wood to 10,000 B. T. U. per pound.

Lignite, about 10,800 B. T. U. per pound.

Bituminous coal, 12,000 B. T. U. per pound.

Anthracite, about 14,000 B. T. U. per pound.

Pure carbon, 14,500 B. T. U. per pound.

In practice, moisture, ash, foreign matter, sulphur, or a surplus of fine dust will greatly reduce the theoretical calorific value of the coal, and an analysis should always be accompanied with a statement as to whether a correction has been made for these impurities, and on what basis.

The complete analysis of coal, together with a bomb test for calorific value, is very valuable in making annual contracts for fuel, but comparatively few engineers know how to use one, or to draw conclusions from the results obtained. The first duty is to obtain a sample of each of the proposed coals, as follows:

Set aside a little pile of about 100 pounds of the coal in question; mix it thoroughly by shoveling to the center; quarter the pile; take one quarter and repeat the process until a five-pound sample representative of the coal is secured. If the coal have large lumps, it is necessary first to break them up fine. A good chemist will prefer to take his own samples, if arrangements can be made.

If coal consists of lumps of one size only, it will take more room per ton than any other kind. The coal that takes the least room per ton is the kind that has all sizes —even fine dust. This principle is used in building pavements, so as to get them dense and hard; and if an engineer wants to get the maximum storage of coal, let him choose that which has all sizes, like run of the mine, provided it has no slate. About one-third more coal can be stored by this method. A ton of anthracite, egg size, will require about 33 cubic feet, and with all sizes about 25 cubic feet. The softer coals run all the way up to 40 cubic feet per ton, even for mixed sizes, according to the hardness and specific gravity. These facts are mentioned because these characteristics should be observed and measured with sieves, when sampling, as follows:

A hundred pounds average sample is taken and put through six sieves, 3-inch, 2-inch, 1-inch, ½-inch, ¼-inch and 1/16-inch. The amount left on each sieve is weighed; the sample is then crushed, quartered, etc., as described. The seive test may represent two extremes, one having so much fine stuff that it will all go through the bars, the other being all lumps that are easy to burn but take a third more space to store.

The next test is the specific gravity, which will be taken and furnished by the chemist. This is the number of times that the lumps of coal are heavier than water, and indicate the hardness and age of the coal. The specific gravity varies from 0.6 for wood and fuels that will float up to 2.2 for hard coal, anthracite and graphitic anthracite. The specific gravity is almost an exact index of the age and softness of a coal. It must be remembered that this is not passed on as a scientific fact, but merely as an empirical index for a practical engineer.

The next test is for moisture. The moisture in coal varies from nothing up to 20 percent and is to be reckoned as an absolute loss; for instance, 10 percent moisture in a pound of coal means (by reference to steam tables) that about 110 B. T. U. are lost from every pound of coal in turning the water to steam. If the coal has a calorific value of 11,000 B. T. U., the loss would be 1 percent. This is not a large amount but is one of the items which add to large total losses.

The next test is for volatile matter, known as hydrocarbons, tarry matter, etc., as distinguished from the pure or "fixed" carbon. This test has several objects, the most important being to determine the general character of the coal and its probable action on the furnace. A coal running more than 90 percent free carbon would be classed as an anthracite. It would be easy to fire and would have about 14,500 B. T. U. calorific value. A coal running 80 percent free carbon would have 15,840 B. T. U., because of the high calorific value of the volatile hydrocarbons which approach oil in calorific value. This type is the most economical and valuable of all steam coals and ranks as a rather soft anthracite or hard bituminous coal. A coal running 50 percent free carbon would have only about 12,240 B. T. U., because, while it has more volatile hydrocarbons, they are so much lighter than the pure carbon that the total drops in value. Such a coal would be hard to fire, and would cake, requiring much work with the bars, besides being very smoky, because a Scotch boiler is a poor furnace in which to burn such coal, as will be explained in detail later.

The test for ash is one of the most important, because

* The first letter on this subject appeared in the April issue.

it takes heat to fuse ash, besides making firing very hard, since ash is clinker, and if the ash have any iron or iron and sulphur (pyrites) the ash will weld on to the grate bars and be very hard to remove; so the ash itself should be analyzed as well as the coal. Coal can contain any amount of ash, according as to how it is mined and separated from the surrounding non-combustible material, but good steam coal should not contain more than 6 percent of ash, and the loss due to ash may be reckoned as approximately equal to the percentage of ash.

The test for sulphur is also very important, because sulphur is a harmful ingredient. By itself it has a calorific value of about 6,000 B. T. U., and in the form of pyrites, in which it usually occurs in coal, about half this value, but this calorific value is negligible compared to the harm done. The sulphur dioxide formed in the process of combustion combines with the moisture formed from the combustion of the hydrocarbons, or the moisture normal to the coal, and generates sulphuric acid vapor, which attacks the iron work of the stack, the boilers and uptakes. Also, the pyrites have a dangerous habit of oxidizing under the action of the air, particularly if in a warm place, until enough heat is generated to cause spontaneous combustion in the bunkers or other storage. It is very bad to admit steam in such cases, because the steam combines with the sulphur dioxide to form sulphuric acid, which reacts on additional steam to generate more heat, and accounts for the fact that bunker fires seem to increase, rather than decrease, under the action of steam.

After receiving the analysis of various coals, they should be compared item by item; the various losses calculated and set against them; after which even a fairly high-priced coal may be found to represent more calorific value and less trouble per dollar than any of the others. Samples of coal put aboard ship should also be taken, and the analyses checked against complaints made by the chief engineer.

A Scotch boiler has the poorest kind of a furnace for getting results from a coal. A hard coal can be burned in such a furnace with fair economy, but a soft coal needs so much flame room and such high temperatures that the volatile parts will condense as soot in the boiler tubes without burning. It does no good to admit air near the bridge wall, because the hydrocarbons will not burn unless incandescent. The ideal conditions would be a fairly large combustion chamber, surrounded with incandescent brick work; air admitted above the fire bed, for the purpose of burning the distilled vapors from the green coal. These vapors are very high in calorific value unless ignited by hot brick work or hot fire bed, and not even then unless supplied with air. These conditions cannot be realized with a Scotch boiler, but they can be approximated by the use of a little brick work judiciously placed, large combustion chambers, air shutters in the doors, methods of firing and a proper cognizance of new types of boilers and combustion methods which tend to better these conditions.

It is certain that nothing adds to the reliability and fuel economy of a marine plant like the selection and use of the fuel, and these letters on the analysis of steam plants aim to begin at the source of the power for analysis and economy. The next letter will analyze the use of coal and the science of firing, with a view to effecting not only an economy of coal, but to increase the efficiency of the fireman with a view to his advancement. These remarks will not be entirely theory, as the writer has served time on the business end of a coal scoop.

E. N. Percy.

Feed Pumps and Methods Used to Overhaul Them

Feed pumps as built and installed are usually a little light in some parts and consequently various methods are being brought to light in handling them. On some ships where feed pumps are located so that the suction is not lower than the bottom of the feed tank there is danger

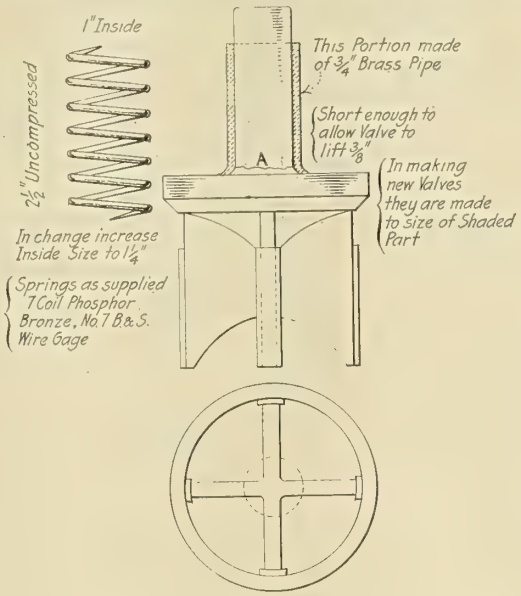


Fig. 1

of the pumps losing a suction when the water is low or the pumps hot, as will be the case at some time or other.

When a pump loses its suction there is danger of breakage of valve stems, as has been found by experience. Some time ago the writer noticed that nearly all such

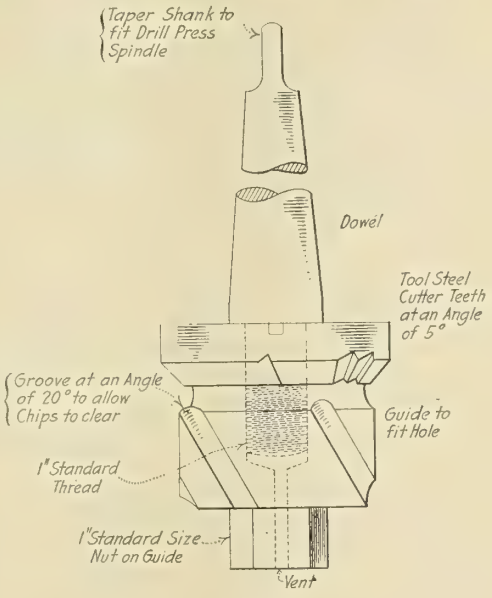


Fig. 2

"breaks" were found at the point marked *A* on Fig. 1. This was overcome by reaming a piece of ¾-inch brass pipe with a ⅞-inch reamer and chamfering the bottom end as shown in Fig. 1, and thus reinforcing the valves that were put in to remove the broken ones. The springs were found to have been spread so that they would pass over the pipe, being nearly 1⅛ inches diameter. This pipe was cut short enough to allow the valve to lift at

least 3/8 inch. This remedy was found to be very effective, but as new valves were cast they were left just that much heavier, as shown by Fig. 1.

When new valves were received on board in the rough they were machined as follows: The first operation was to chuck them in a four-jaw chuck, being careful to true up well and turning them to size, as shown by Fig. 1. They were then taken and machined to size on the other end by holding them in a special spring collett, and when they needed refacing they were easily trued up, as all that was required was to put them in the same collett. This method cut down the time required to overhaul any pump of this make.

Of course, as the stem did not break very frequently, there were some other things that needed attention, and it was found that the wear on seats was such that they had to be reseated as often as the pump was stripped for overhaul. As this was a long job when done in the old way by chucking the seat clusters in a lathe for each seat, to overcome this a special cutter was made as shown by Figs. 2, 3 and 4. Fig. 2 shows a general view while Figs. 3 and 4 show more detailed views of the cutter and guide.

The shank was machined of a piece of mild steel on centers. The first operation was to machine to fit the drill press spindle, then machining the shoulder and the lower end, making it a standard 1-inch body bound fit, and cutting a standard 1-inch thread; then it was taken out and a dowel placed in position, as shown. Next a piece of tool steel was taken and machine-faced on one side and a hole bored to fit the shank. We then put on an arbor and faced the other side. A slot was machined to receive the dowel. It was then put on the shank and machined to size and angle. The teeth were milled, being cut at an angle of 5 degrees and undercut so that they could be easily reground. The reason that the teeth were cut at an angle was so that the cutter would sort of drag and not have a tendency to pull itself into the work. The piece was then tempered.

The last operation consisted of machining the guide. This was done by taking a piece of mild steel, facing one end and drilling and tapping to 1 inch. This was then screwed on the shank when the cutter was in place, and as the centering hole was used to hold the center cutter in line, it was then turned to proper size to act as a guide. After this operation the nut part was milled and the grooves were milled out at an angle of 20 degrees, so that the chips would all pass out and not clog the cutter.

Fig. 5 shows the cutter in position for use and, as will be seen, it was necessary to have a special bolt and two washers to hold the seat cluster in its proper position. Also one sleeve was needed when reseating discharge seats, as the hole in them is slightly larger than the hole in the suction clusters. Once having the cutter shank in place and clusters at hand, it is only necessary to bolt a cluster in place, as shown, and then all that is needed when one seat is finished is to revolve the press table the required distance, which is one-fifth of a revolution. It was found that they could be reseated much quicker and much evener, as the press spindle stop can be brought into play, so that all seats will be same depth when finished.

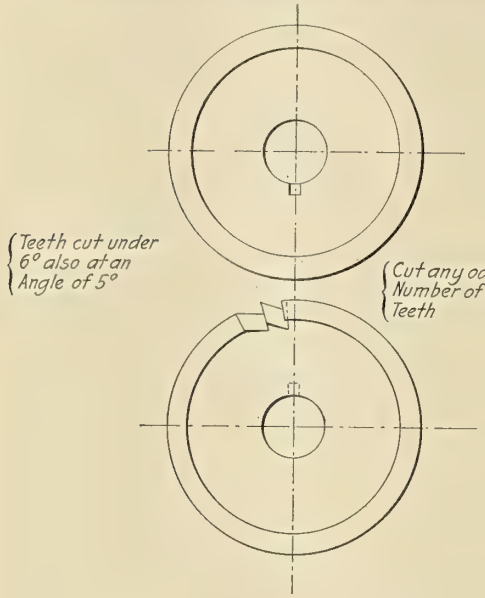


Fig. 3

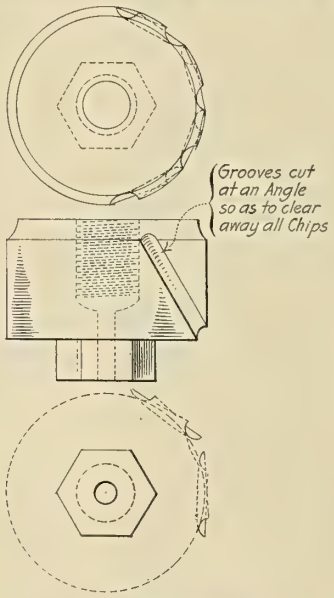


Fig. 4.—Details of Guide

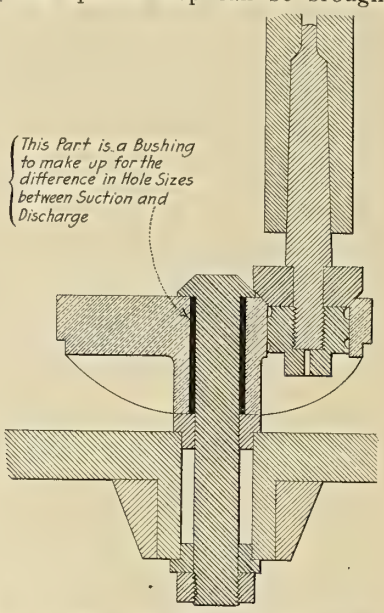


Fig. 5.—Reseating Cutter in Position on Radial Drill Press

The tool just described is considered to be one of the handiest tools that we have on the ship, as we find with this it becomes a very easy matter to reseat the valves, whereas formerly that part of the work was always thought to be the most tedious of the whole lot. While the sketches which illustrate this letter are somewhat crude, as the writer did not have the time to prepare finished drawings, nevertheless they are offered with the hope that others may see where they are losing a lot of time in overhauling the same make of feed pumps. As this letter refers only to the overhauling of the water end of the pumps, a later letter will take up the matter of overhauling the steam end of feed pumps.

F. C. Wolf,
Machinist, U. S. N.

Cadetships in the United States Coast Guard.—A fine opportunity for young men to obtain life positions in the Government is presented by examinations which will be held on June 26 at Washington, D. C., and at several other large cities in different sections of the country to fill about ten vacancies in the line and engineer corps at the Coast Guard Academy, New London, Conn. The course at the Academy covers a period of three years for line cadets and one year for cadet engineers. Information regarding the requirements for candidates for these examinations and the pay received by the cadets and by the commissioned officers after graduation can be obtained from the Captain-Commandant, U. S. Coast Guard, Treasury Department, Washington, D. C.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Steam Consumption of Direct Acting Simplex Feed Pump

Q.—Will you tell me about how much steam an ordinary direct-acting simplex feed pump uses? S. P.

A.—A pump of the type mentioned, working under service conditions and in a normal state of maintenance, gave the following results when tested in the laboratory. It is easy to see from this why pumps of this sort are classed as "steam-eaters" aboard ship:

TEST OF STEAM PUMP, 7-INCH BY 4-INCH BY 10-INCH STROKE, DISCHARGING AGAINST A BOILER PRESSURE OF 190 POUNDS GAGE

Throttle Pressure Abs.	Piston Speed Ft. Per Min.	Steam Per I. H. P. Hr.	Water Pumped (Lbs.) Per Lb. Steam
72	37.8	144	32.4
81	57.0	133	34.0
88	67.2	111	39.0
88	81.6	72	60.3
91	98.0	67	73.0

Hatchet Planimeter

Q.—What is the so-called "hatchet planimeter"? I have heard it mentioned as being a planimeter that could be made by a fellow without elaborate tools, and am interested to know if that is so, and if so, how to make it? DRAFTSMAN.

A.—The hatchet planimeter consists of a single rod of metal bent into the form of a shallow inverted U. One end is sharpened to a point and the other has a sharp edge like a knife edge, whose plane passes through the tracing point. It is used by starting the tracing point as near the center of gravity of the area to be measured as can be estimated, then over the straight line to the boundary, and thence around the boundary in a right-handed direction and back along the original line to the starting point. The distance between the initial and final positions of the knife edge multiplied by the length of the arm from the point of contact of the knife edge to the tracing point (all in inches) gives the area in square inches. It is not accurate and needs to be kept vertical at all times. Its inaccuracies are minimized by going over the area a second time in the reverse direction, and averaging the two results.

Rule for Expansion of Steam

Q.—(1) What is the approximate rule for the expansion of steam; that is, if you knew the initial pressure and the point of cutoff, how can you estimate the pressure at the end of the stroke?

(2) How would you estimate by the same rule the pressure at the part of the stroke after cutoff has occurred? J. K.

A.—There is no expression which accurately represents the action of steam expanding in the cylinder of a steam engine. A common expression and the easiest to work with mathematically, is $P \times V = P_1 \times V_1$, and probably this will be sufficiently close for your purpose:

P = pressure, absolute pounds per square inch at cutoff.
V = volume in cubic feet at cutoff, including clearance.
P_1 = pressure desired at V_1.
V_1 = cylinder volume in cubic feet to point desired + clearance volume.

An investigation recently carried out by Clayton * to determine the relationship between the expansion line and the quality of steam at cutoff indicates that the expansion line may be represented in the case of non-jacketed engines by the expression $P \times V^n = P_1 \times V_1^n$, where n varies from 0.8 to 1.2, depending upon the type of engine, the location of cutoff, initial pressure, etc. The following, taken from a small triple expansion marine engine in the laboratory, may be of interest and will show how wide the variations are in practice in different ends of the same cylinders when the engine is operating under uniform conditions:

	Cut-off	n
High Pressure Cylinder—		
Crank end	.58	.89
Head end	.65	.92
Intermediate Cylinder—		
Crank end	.67	.82
Head end	.69	1.0

$I.H.P. = 40$ $R.P.M. = 180$

Engine $= \dfrac{6\frac{1}{2}'' \times 9\frac{3}{4}'' \times 16''}{10''}$, boiler pressure = 120 lbs. gage.

The method of using the first expression suggested is best shown by an example. Let us suppose the cylinder clearance is 10 percent, cutoff = ½ stroke, and pressure at cutoff is 100 pounds above the atmospheric line. It is desired to predict approximately the pressure at ¾ stroke and at 0.8 stroke. The strokes are directly proportioned to the volume displaced by the piston plus the clearance; so that if we let D = the entire piston displacement it drops out of the expression, and we can deal with strokes instead as follows:

$$P V = P_1 V_1 \quad P_1 = P \frac{V}{V_1} = (100 + 14.7) \frac{\frac{1}{2} D + .1 D}{\frac{3}{4} D + .1 D}$$

$$= (114.7) \frac{.6}{.85} = 80.9$$

pounds absolute for the pressure at ¾ stroke, and

$$(114.7) \frac{.6}{.9} = .764$$

pounds absolute for the pressure at .8 stroke.

Michell and Kingsbury Thrust Bearings

Q.—Kindly give some information, with diagrams, in MARINE ENGINEERING, regarding the Michell thrust bearing? V. C.

A.—The evolution of the high pressure thrust bearing of the Michell and Kingsbury types extends back over a long period of time and is intimately associated with the theoretical and experimental investigation of lubrication. Much experimental work was done from 1873 to 1903, and as far back as 1884 Lord Rayleigh presented a complete mathematical treatment of the general theory. A few years later (1886) Professor Osborne Reynolds tied in the general analytical treatment with the experimental work of

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

* A New Analysis of Cylinder Performance of Reciprocating Engines, by A. Paul Clayton. University of Illinois Bulletin No. 26.

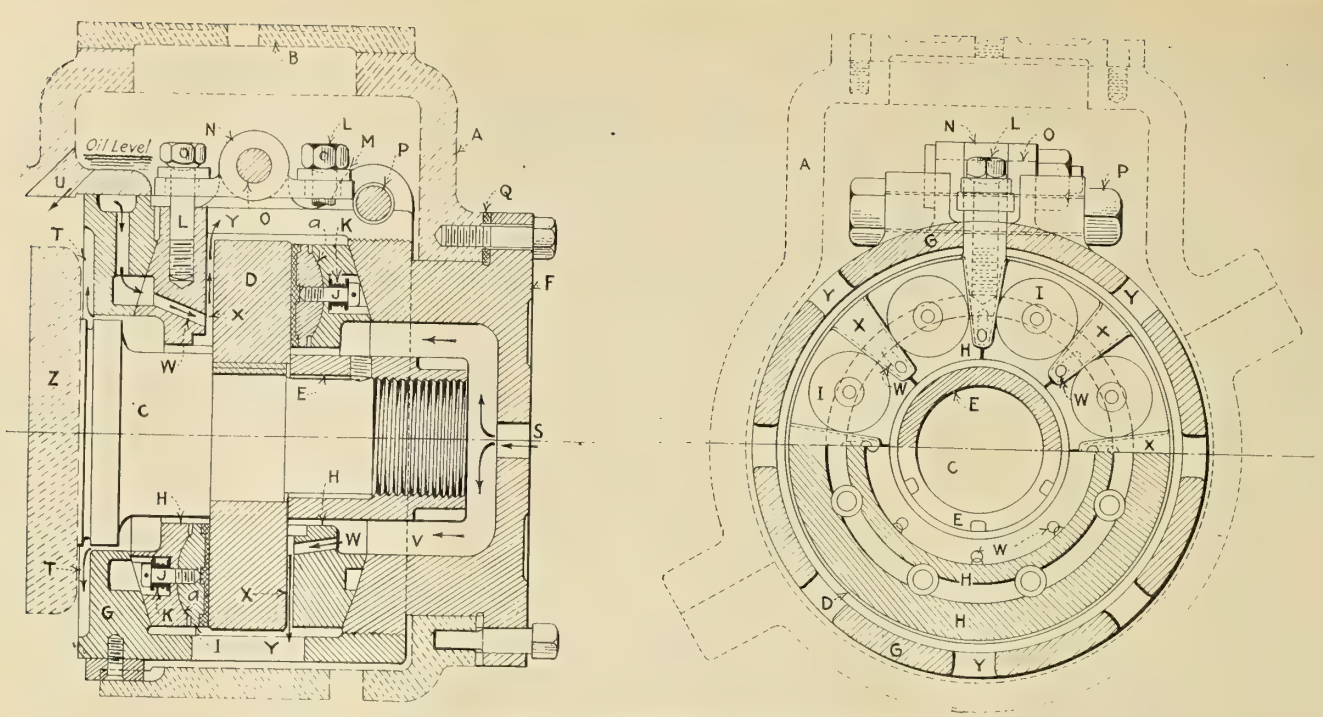


Fig. 1.—Sections of the Kingsbury Thrust Bearing

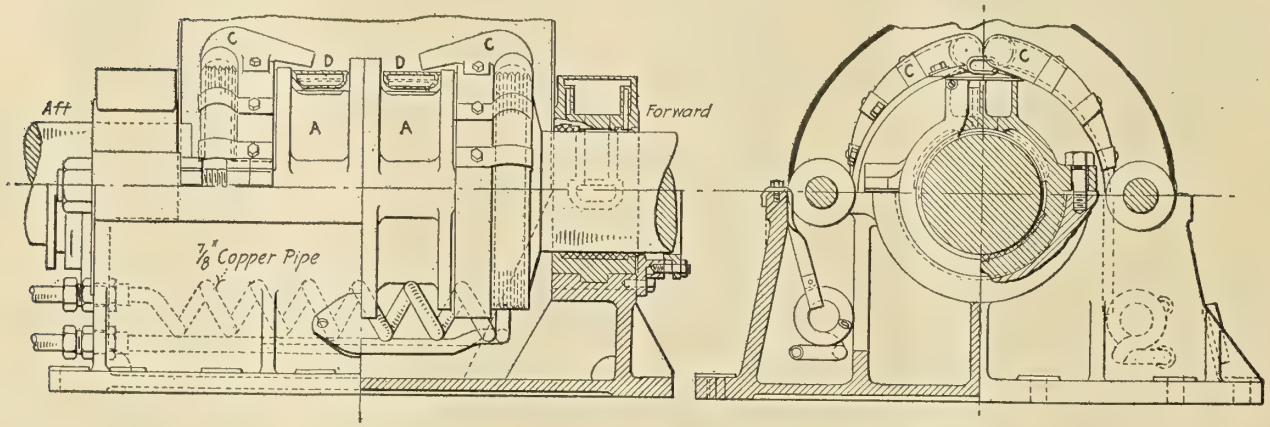


Fig. 2

Fig. 3
Section at Z-Z

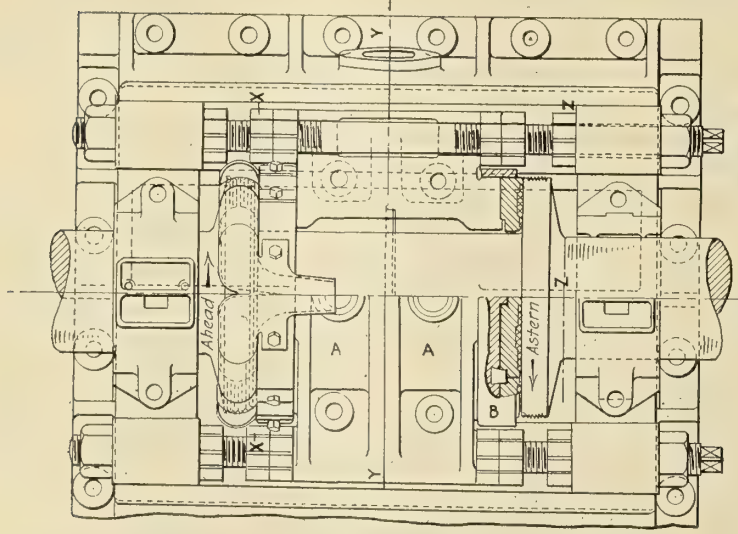


Fig. 4

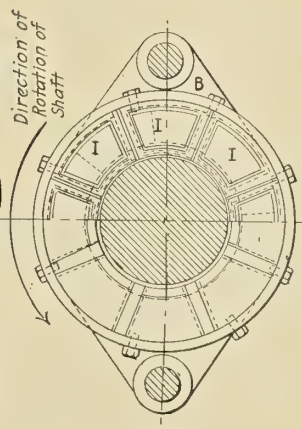


Fig. 5
Section at X-X

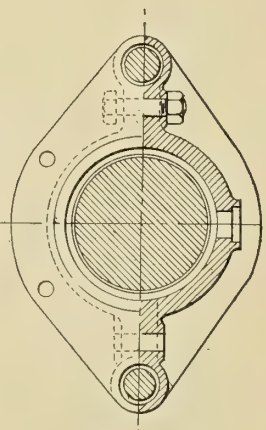


Fig. 6
Section at Y-Y

(Drawing reproduced from *Engineering*)

Details of the Michell Thrust Bearing

Tower, and this seems to have furnished the basis of the development of the Michell bearing.

Michell's patent was issued in 1905, and had been preceded by considerable experimental work carried out by him. In this bearing, the thrust is borne by annular blocks (*I-I-I*, Fig. 5) pivoted at their theoretical centers of pressure, which lie three-fifths the length back from the leading edge. When running, these blocks tilt slightly about this pivot, as in Fig. 8, and the film of oil is drawn into a gradually contracting channel, giving perfect lubrication and permitting extremely high bearing pressures to be carried.

Where about fifty pounds per square inch has been the generally accepted figure for marine work these bearings operate customarily at about 500 pounds per square inch and with an enormous reduction in friction losses.

A further development of this idea was the pivoting of the slippers at their centers, as in the patents gotten out by Ferranti (1910) and Sir Charles Parsons (1912) in Great

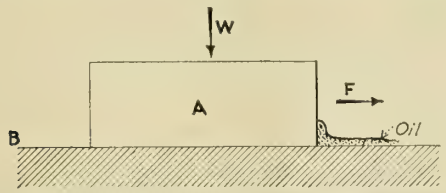


Fig. 7.—Ordinary Collar Bearing. Oil Squeezed Out and Surfaces in Metallic Contact. Coefficient of Friction About 0.03

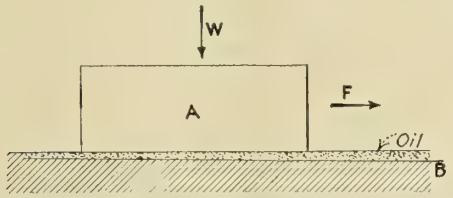


Fig. 8.—Michell Bearing. Wedge of Oil Maintained Between the Surfaces and No Metallic Contact. Coefficient About 0.003

Britain, and Kingsbury (1910) (Fig. 1), in the United States. This seems to work equally well and has the further advantage that the shaft may run in either direction without shifting the point of support. These principles have also been applied to journal bearings by Michell (1911) and Parsons (1912-1913).

Tests were carried out by the Westinghouse Machine Company to determine the maximum pressures which could be carried by a Kingsbury bearing, and the results were astonishing. Starting with a bearing pressure of about 1,000 pounds per square inch, the pressure was increased successively over a series of runs until it reached 7,000 pounds, when the babbitt was squeezed out, but no trouble was experienced from failure of the lubrication, and the conclusion was that the unit pressure was limited by the flowing pressure of the bearing lining. It was further an interesting fact that the babbitt flowed on the leading edge or opposite to the direction of rotation, as well as the other three edges. The coefficient of friction for the Kingsbury thrust bearing has been found by a large number of tests to vary from .0008 to .003, and the value commonly taken for calculation is .002. This corresponds to values for good ball-bearings, though the starting or initial friction is considerably higher. Bearings of this character have been successfully applied to many steamships and turbine installations and have given satisfaction.

Following is a description of the Michell bearing installed in the *S.S. Cuidad de Buenos Aires,* as published in *Engineering* (London), December, 1914:

Details of the construction of the bearing are shown in Figs. 2 to 6. The shaft, which is 9 inches in diameter, rests on ordinary bearings at each end of the thrust-block housing (see Figs. 2 and 3), and has but two collars, of which one is used in forward running and the other when running astern. One of these collars is shown exposed in Fig. 4, the distance between the opposite faces of the two being 20 inches.

A bridge-piece *A*, Figs. 2 and 4, embraces the shaft between the collars, being split in halves, as shown in Fig. 6, so that it can be placed in position. It is provided with lugs to take the 2¼-inch bolts shown in Fig. 4, by which the thrust is finally transmitted to the housing, and is clamped in place by the double nuts shown. Besides being split radially, the bridge-piece is also divided along a plane normal to the axis of the shaft, the components being held together by bolts passing through the 1¼-inch flanges shown. This joint makes possible small adjustments in the total length of the bridge-piece by using in the joint packings of different thicknesses. A set of eight pivoted blocks (see Fig. 5) at each end transmits the thrust from the corresponding collar to the bridge-piece. Keys let into the faces prevent the segmental blocks being carried round by the motion of the opposing collar, while they are held in place radially by half hoops *B* of steel, studded to the bridge-piece, as best seen in Fig. 5. To ensure an ample supply of lubricant, the collars dip into oil confined in the lower part of the housing, and by the serrations shown pick up oil, which they deliver to the guides *C*, which feed the oil-cups, shown in the bridge-piece at *D*. These, by appropriate channels, deliver the oil to the annulus between the shaft and bridge-piece, best seen in Fig. 6. From this annulus the oil makes its way out and back into the housing again, between the faces of the collars and segmental blocks. A light, wrought iron cover protects the block from the dust and dirt of the engine room.

Lubricant for Use in Cutting Threads in Mild Steel Bolts

Q.—Can you give me the constituents of a lubricating compound to be used when cutting screw threads on mild steel bolts? I have used lard oil, but some time ago worked with a made-up compound which worked better and which I was told had no lard oil in it. Machinist.

A.—A good screw-cutting oil can be made by taking three parts of any parrafin base oil of about 29 degrees Baume and mixing with it one part of cottonseed oil.

Viscosity Seales

Q.—Will you please give me the formula for converting viscosity in the Saybolt scale to the Engler scale? L. B.

A.—For values up to 500″ Engler and 160″ Saybolt *A*, 0.32 Engler = Saybolt *A* — 4.6.

For values 500″ to 1,200″ Engler and 160″ to 370″ Saybolt, 0.32 Engler = Saybolt *A* — 6.0.

Overheating of Enclosed Motors

Q.—I have a 3-horsepower, 1,000 revolutions per minute, motor which is now operating under about three-quarter full load. This motor is so situated as to be liable to be wet, and I wish to make some covers to totally enclose it. Will the motor overheat if totally enclosed? E. E.

A.—Probably not; the temperature rise may be about what the motor would have at full load. If the rise exceeds 40 degrees Centigrade or 72 degrees Fahrenheit you better provide ribs on the covers to increase the radiating surface or open the covers slightly.

Marine Articles in the Engineering Press

Lubrication—Descriptions of 14,000-Ton Floating Dry Dock and Torpedo Boat Destroyer—Education of Apprentices

Practical Lubrication.—By Lieutenant G. S. Bryan, U. S. N. A brief explanation of the general information needed to assist an engineer with lubrication problems. The article discusses the effect of temperature, load and speed on bearings. In selecting suitable oils for lubrication three factors must be considered—temperature, pressure and journal running speed. The physical constants which must be understood are viscosity, flash point, fire point, specific gravity, color and cold point. The general qualifications are explained for marine engine oil, forced lubrication oil, motor cylinder oil, steam cylinder oil, ice machine oil, dynamo oil and air compressor cylinder oil and the paper is concluded with a discussion of the value of greases and graphite as lubricants. 4 illustrations. 5,000 words.—*Journal of the American Society of Naval Engineers,* November, 1915.

A *Floating Dock of* 14,000 *Tons Lifting Power at Rotterdam.*—The docking facilities at Rotterdam have recently received an important addition by the installation at that port of a large floating dock of 14,000 tons lifting power which has been built at the order of Wilton Engineering & Slipway Company by the Nederlandsche Scheepsbouw Maatschappij of Amsterdam. The dock is 510 feet long overall and 110 feet extreme width, capable of accommodating a vessel with a draft of 20 feet 6 inches. The dock is of the bolted sectional type and is divided into three sections for self-docking purposes, the sections being so arranged that when disconnected any two of them can lift the third. The pontoon of the end section is divided into sixteen watertight compartments by transverse and longitudinal watertight bulkheads, while the pontoon of the central section is similarly divided into twelve compartments. The necessary transverse strength of the pontoon is provided by strong transverse girders spaced at 10-foot intervals. Between these girders are arranged longitudinal frames which are diagonally braced across the corners. Transverse framing is also adopted for the side wall. The pumps for operating the dock are electrically driven, the current being supplied from the shore. Each section of the dock is self-contained in regard to pumping arrangements on account of the self-docking feature. 6 illustrations. 600 words.—*The Shipbuilder,* January.

Description and Trials of the United States Torpedo Boat Destroyer Cushing.—By Lieutenant Ormond L. Cox, U. S. N. The *Cushing,* built by the Fore River Shipbuilding Corporation, Quincy, Mass., is a twin screw vessel fitted with Curtis turbines with geared cruising turbines and designed for a speed of 29 knots at about 1,050 tons trial displacement with the main engines developing about 16,000 shaft horsepower. The vessel is 300 feet long between perpendiculars 31 feet 1 inch extreme beam and 17 feet 1 inch molded depth with a load draft of 9 feet 5½ inches. The turbines are designed to develop about 8,000 shaft horsepower running at about 550 revolutions per minute. The cruising turbines are designed to develop 450 shaft horsepower each at 2,000 revolutions per minute and are geared down in a ratio of 7.95 to 1. The cruising unit may be used at all speeds ahead below 16 knots and are disconnected for higher speeds ahead and while reversing. The propellers are three-bladed, of manganese bronze cast solid 7 feet 5½ inches diameter and 6 feet 6⅛ inches pitch, with a projected area of 26.797 square feet; a helicoidal area of 29.67 square feet, and a disk area of 43.69 square feet, making the ratio of projected to disk area .1633, of helicoidal to disk area .6791, and of projected to helicoidal area .9032. Steam is supplied at 265 pounds gage by four oil-burning Yarrow boilers arranged in pairs in two separate compartments, operating under the closed fireroom forced draft system. On her standardization trial a speed of 29.68 knots was attained with the propellers turning at 593.84 revolutions per minute and the engines developing 16,384 shaft horsepower. On the four-hour full speed trial the speed was 29.183 knots on a displacement of 1,048 tons and a draft of 9 feet 5 inches. The main turbines developed 15,280 horsepower, turning at 576.06 revolutions per minute. The evaporation of the boilers was 11.31 pounds per hour per square foot of heating surface, 15.61 pounds per hour per shaft horsepower, and 12.46 pounds per hour per pound of oil. The oil consumption was 1.259 pounds per shaft horsepower hour. 1 illustration, 3 plates, 3 tables. 4,700 words.—*Journal of the American Society of Naval Engineers,* November.

Education of Youths Before and During Their Apprenticeship.—By V. A. Mundella, M. A., B. Sc. A careful analysis of the present system of education in a typical engineering and shipbuilding center in England leads to the conclusion that the important problem is that of the continued education of the elementary school boys. Out of 1,200 branches in the engineering trades, only 38 percent are accounted for as attending evening or day classes, and in the shipbuilding trades only 12 percent are accounted for and more than half of these attended single-subject classes only. Though the attendance of those in the evening classes is good, nevertheless a large percentage of students failed to make satisfactory progress. Furthermore, a large proportion—54 percent—of the students in attendance allowed one or more years to elapse after leaving school before taking up any continued education. This position is considered by the author as unsatisfactory, and he points out the necessity for some form of compulsory continued education. The author considers that the real basis of an effective system of continued education is compulsion in some form or other. Compulsory higher education, he holds, is now a perfectly safe investment, but the returns from the investment cannot be expected immediately; they must be looked for in years to come. 9,000 words.—*Transactions of the North East Coast Institution of Engineers and Shipbuilders,* March.

Cast Iron for High Speed Engine Cylinders.—In modern high speed steam and internal combustion engines, cast iron is up to the present the only metal which has given satisfactory working results when used for the construction of certain vital parts, such as pistons, piston rings and cylinders. The two chief properties required of cast iron for these purposes are maximum resistance to wear and the most perfect running properties under the conditions existing in the engine. The mechanical properties, such as tensile and transverse strength, can usually be obtained sufficiently high to withstand the stresses involved in the use of the generally accepted thickness of material. The modern tendency, however, seems to be to cut down the weights of members, and for this reason higher tensile strength irons will be more and more in demand.—*Engineering.*

Shipbuilding and General Marine News

Contracts for New Ships—Marine Terminal Improvements—Recent Launchings—Improved Appliances—Personal Items

Contracts for New Ships

The Harlan & Hollingsworth Corporation, Wilmington, Del., has received a contract from the United Fruit Company, Boston, Mass., for three freight ships, each of about 5,000 tons gross register.

The Newport News Shipbuilding & Dry Dock Company, Newport News, Va., has received a contract from the Munson Steamship Line, New York, for a 385-foot steamship of 4,600 tons gross register. This is the fourth ship that the Munson Steamship Line has building in Newport News.

The American Shipbuilding Company, Cleveland, Ohio, has received a contract from the Clyde Steamship Company, New York, for four steamers of full canal size to be built from plans drawn by Theodore E. Ferris, naval architect, New York. These vessels were previously erroneously reported to have been ordered by the Mallory Line.

The Pittsburg Steamship Company, Cleveland, Ohio, now has under contract six 12,000-ton ore vessels, four of which will be built by the American Shipbuilding Company, Cleveland, Ohio, and two by the Great Lakes Engineering Works, Detroit, Mich.

The Fore River Shipbuilding Corporation, Quincy, Mass., has received a contract from the Luckenbach Steamship Company, New York, for a fifth steamship.

The Fore River Shipbuilding Corporation, Quincy, Mass., has received a contract from the Mexican Petroleum Corporation, New York, to build two oil tank steamships.

It is reported that the Submarine Boat Corporation, New York, has received a contract from the Russian Government to construct 250 submarine boats at a cost of approximately $70,000,000 (£14,300,000). These boats are to be built in Russian shipyards.

The Newport News Shipbuilding & Dry Dock Company has received a contract from the Standard Oil Company, New York, for the construction of two oil tank steamers to cost about $1,000,000 (£205,000) each. Each vessel will have a carrying capacity of 11,000 tons deadweight. They will be the largest vessels of their class ever built in this country. Both will be oil burners.

The American Shipbuilding Company, Cleveland, Ohio, has received a contract from Hasler Brothers, Inc., New York, to build a freight steamship.

The American Shipbuilding Company has received a contract from Barber & Co., New York, to build a freight steamship.

The American Shipbuilding Company has received a contract from the British Columbia Sulphite Fibre Company to build a freight steamship.

The Moore & Scott Iron Works, Oakland, Cal., has received a contract from the Huasteca Petroleum Company, New York, for an oil tank steamship of 10,000 tons deadweight carrying capacity.

The New York Shipbuilding Company, Camden, N. J., has received a contract from the Darrow-Mann Company, Boston, Mass., to build two more colliers. Each vessel will be 369 feet long and will have a capacity of 8,500 tons.

The Great Lakes Engineering Works, Detroit, Mich., has received a contract from Gaston, Williams & Wigmore, Inc., New York, for two 5,000-ton vessels to be delivered in May, 1917.

The Seattle Construction & Dry Dock Company, Seattle, Wash., has received a contract from the Luckenbach Company, New York, to build a steel steamship of 11,000 tons deadweight carrying capacity.

The Chester Shipbuilding Company, Chester, Pa., has received contracts for seven ships in addition to the seven contracts already reported.

R. L. Bean, Camden, Me., will build six four-masted schooners.

The American Bridge Company, Pittsburg, Pa., will build four steel barges for Dollut & Williams, New Orleans, La.

The American Bridge Company is also building four hulls for the United States Government.

The Schultze Shipyard Company, South San Francisco, Cal., has received an order from the Angelo Fasce Company, Callao, Peru, for the construction of an 85-foot cargo schooner to be equipped with a 120 brake horsepower oil engine.

Shipyard Projects

Announcement is made of a new $5,000,000 (£1,025,000) shipbuilding plant, known as the Sun Shipbuilding Company, to be located on the Delaware River at Chester, Pa. The new company plans to specialize in the construction of 10,000-ton freighters and oil tankers, and six building ways will be provided, each capable of taking a vessel 700 feet long. Two thousand five hundred men will be employed at the plant and actual building of vessels will be begun within the next month, the first to be completed by August 1. Contracts for two tankers for the Sun Oil Company, and for four more for other interests, are already in hand.

The United States Senate has passed a bill appropriat- $2,065,000 (£423,000) for equipping the Puget Sound, Wash., Navy Yard for building battleships.

It is reported from Portland, Ore., that the Smith & Watson Iron Works and the Columbia Engineering Works will combine to organize a shipbuilding company.

It is reported that the old Crescent shipyard of the Samuel L. Moore & Sons Corporation, at Elizabethport, N. J., is to be overhauled and arrangements made for the building of steamers up to 300 feet in length. Considerable machinery will be purchased a little later.

Marine Terminal Improvements

It is reported from Houston, Tex., that the wharfage facilities of that port are to be increased by the construction of a second municipal dock at an estimated cost of $400,000 (£82,000).

The Vacuum Oil Company, New York, has purchased a large tract of land in Lincoln Park, N. J., and is planning to build piers, warehouses, factories, machine shops, etc.

The Norfolk & Western Railway Company is building two large steamship piers at Lambert's Point, Va., one for outgoing and the other for incoming freight. The new piers will be fully equipped with Otis inclined elevators, manufactured by the Otis Elevator Company, New

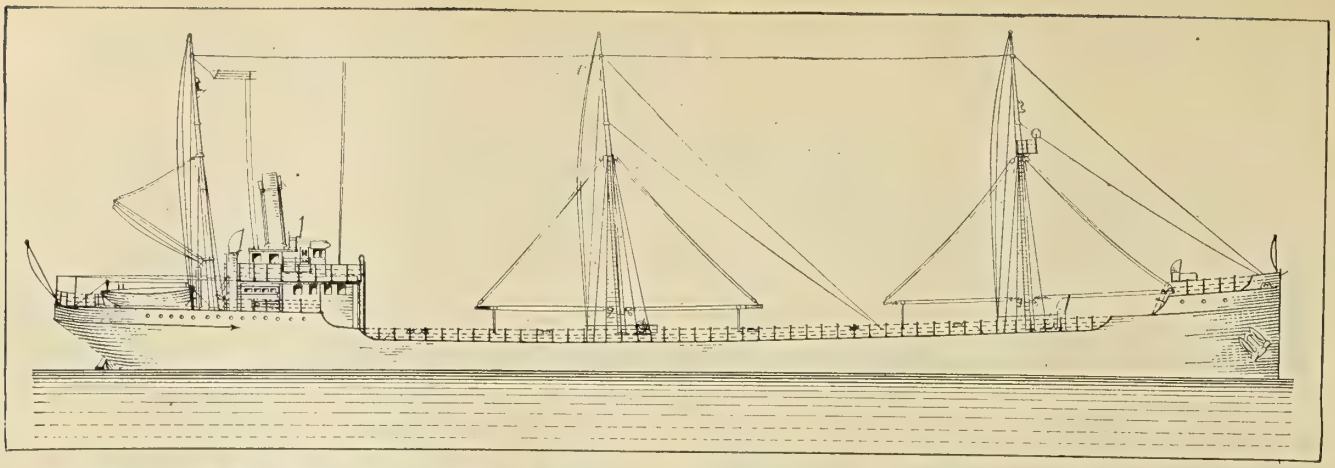


Fig. 1.—Outboard Profile of Motor-Driven Oil Tanker Building for Christoffer Hannevig, Christiania, Norway, by the Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md., in Accordance with Designs by Cox & Stevens, Naval Architects, New York

York. In all, forty of these elevators will be installed, making the largest installation of this type of freight-handling machinery that has as yet been made at a steamship terminal.

W. H. Stark and the Orange Ice, Light & Water Company, Orange, Tex., are planning to build a 730-foot wharf along the Sabine River front.

The city of Norfolk, Va., is planning to construct docks at a cost of more than $500,000 (£102,500).

The U. S. Engineer Office, Galveston, Tex., accepted bids until April 11 for constructing a wharf at Arkansas Pass, Texas.

Annual Banquet of the American Society of Marine Draftsmen

The annual banquet of the American Society of Marine Draftsmen was held at the Hotel Warwick, Newport News, Va., on Saturday evening, April 22. Arrangements for the banquet were made by a joint committee of the Newport News and Norfolk branches of the society, and representatives of 85 percent of the marine draftsmen of the United States were present at the banquet.

Fast Trip of Steam Yacht Whileaway

The steam yacht *Whileaway*, designed by Messrs. Cox & Stevens, naval architects, New York, and built by the William Cramp & Sons' Ship & Engine Building Company, Philadelphia, Pa., for Mr. Harry Payne Whitney, recently made a record run from Key West to Havana, Cuba, making the trip from light to light in four hours forty-seven minutes, bettering the time of the steamers *Governor Cobb* and *Olivette* on this run. The *Whileaway* is an entirely new type of vessel, and it is thought that she will be a forerunner of many more yachts, as she caters particularly to the requirements of American owners, who for the most part use their vessels during warm weather, and therefore require large and well-ventilated and lighted quarters. A further requirement of the average American yacht owner is that he must be able to move quickly from one port to another and be able to enter all of the harbors along the Atlantic coast, thus making a moderate draft of the vessel essential.

The *Whileaway* is 177 feet long over all, 25 feet beam, 9 feet maximum draft, and has a cruising speed of 16 knots. Propulsion is by twin screws driven by Parsons turbines supplied with steam by oil-burning boilers. When forced, the vessel is capable of a speed in excess of 18½ knots.

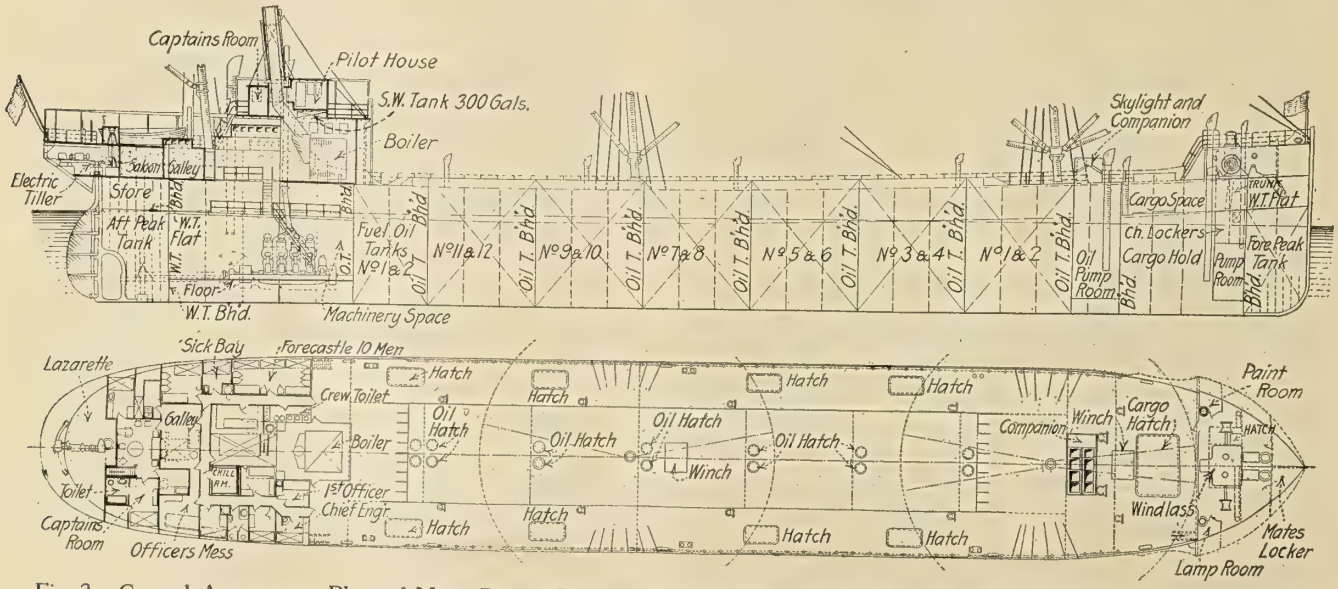
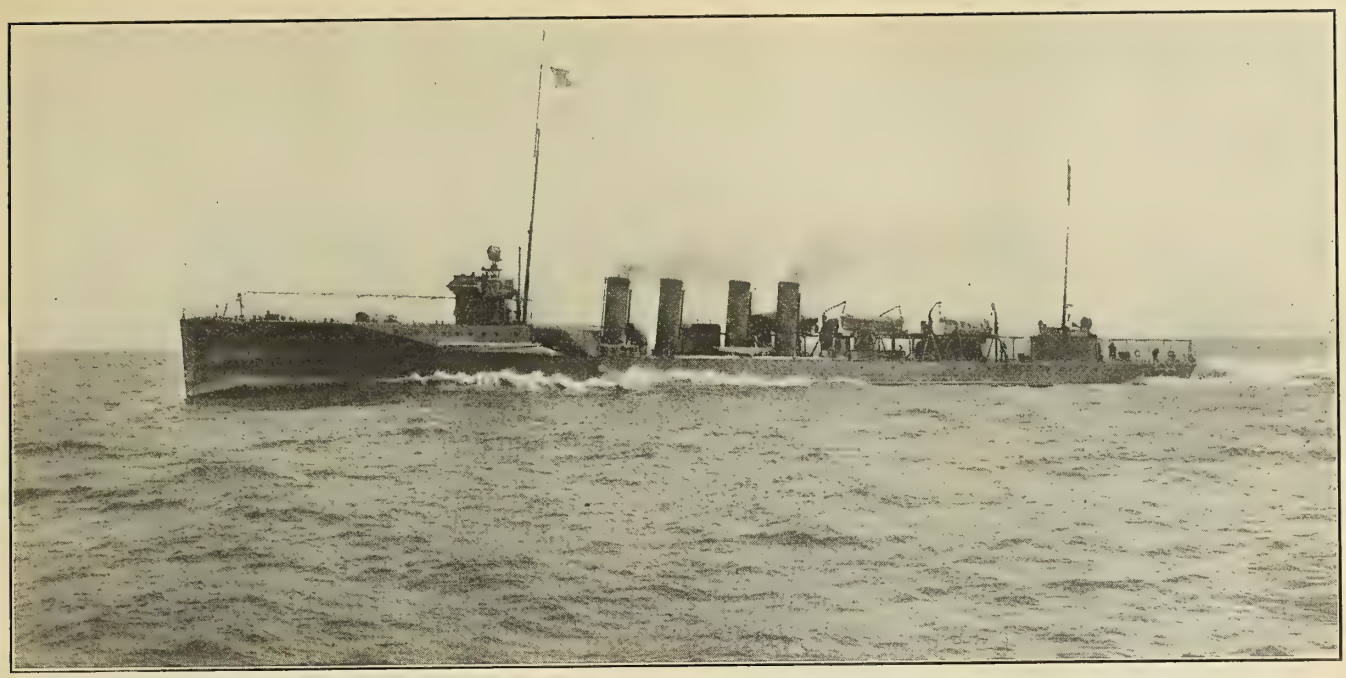
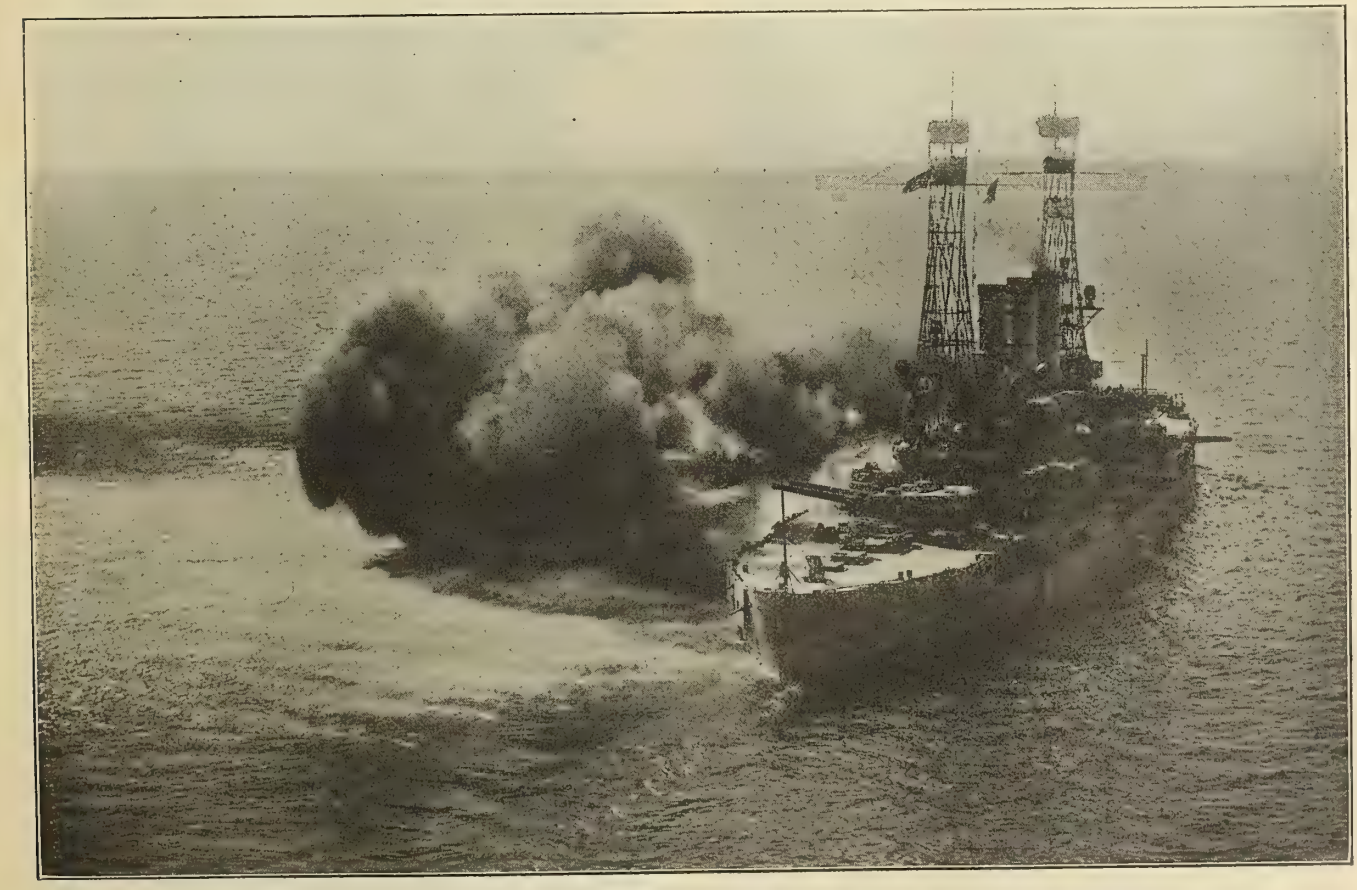


Fig. 2.—General Arrangement Plans of Motor-Driven Oil Tanker 306 Feet Long, 47 Feet Beam and 28 Feet Depth, to be Propelled by Three Screws, Each Driven by a 600-Brake-Horsepower Bolinders Oil Engine. Four of These Vessels Now Building Will Be Followed by Three Others Propelled by Geared Steam Turbines



United States Torpedo-Boat Destroyer *Wainwright*, Just Completed by the New York Shipbuilding Company, Camden, N. J.
Speed on Trial, 31.52 Knots

In type, the *Whileaway* is a development of the large motor cruiser, having all the comforts and roominess of the houseboat, with large windows in place of air ports, a great amount of deck space and unusual head room. At the same time she has excellent qualities as a seagoing boat. The designers of the vessel report that as a result of the successful performance of the *Whileaway* and the remarkable combination of comfort, speed and seaworthiness which she represents, they are now designing several other large steam yachts of the same general type, among these being a 240-foot, 26-knot vessel for Mr. J. N. Willys, which is being built by the Bath Iron Works, Bath, Me.



United States Battleship of the *New Hampshire* Class Firing a Broadside in Practice Maneuvers

ENGINEERING SPECIALTIES

Correction

In the description of a 24-foot motor lifeboat published on page 220 of our April issue, it was erroneously stated that the lifeboat described was built by the Welin Marine Equipment Company, Long Island City, N. Y. The manufacturers of this type of lifeboat are the Gas Engine & Power Company and Chas L. Seabury & Co., Consolidated, Morris Heights, New York.

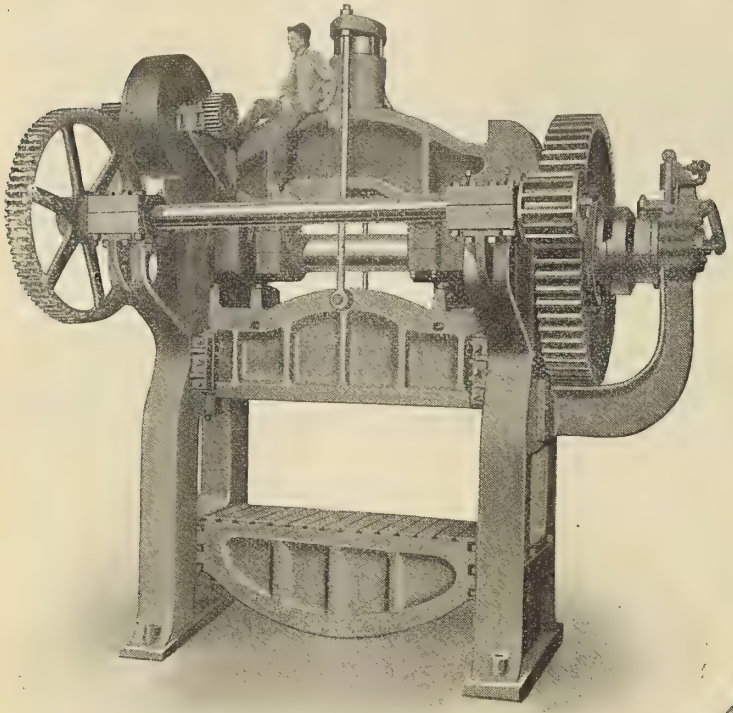


Fig. 1.—Covington Multiple Punch

Covington Punches

The Covington Machine Company, Covington, Va., has on the market a special line of tools for shipyard work, including punches, shears, bending rolls and plate planers.

Fig. 1 shows a large multiple punch located at the plant of the Pressed Steel Car Company, McKees Rock, Pa. This machine was designed for punching, among other operations, four sides of what is known as the "bath tub bolster" at one stroke. Its capacity is sixty 13/16-inch holes and one 2½-inch hole through ¾-inch mild steel plate at a single stroke. The dies and holders are not shown in this photograph, but are fastened to the head and bedplate, respectively. The weight of this machine is 185,000 pounds; the main frames and bolsters are of steel castings, and the width between housings is 122 inches. By the use of modern spacing tables, which the Covington Company furnishes, a multiple punch of less size than the one illustrated can be made to produce large returns for punching flat sheets. The end rows of holes are all punched at one stroke, the girth seam holes being punched on both sides at once. A spacing table can be arranged to punch approximately rectangular sheets so that slightly conical sections can be automatically punched. The advantages of such an arrangement for shipyards handling a large amount of work are obvious.

In Figs. 2 and 3 are shown the application of universal jaws on punches, an arrangement which is not fully appreciated by many shipbuilders. While this form of jaw is not recommended for machines that are to be used almost exclusively for shearing work, nevertheless in small shops, where a wide range of duty is desired from a single tool, the construction is very desirable, as flanges and channels and deep angle irons can be punched with ease, and at the same time shear blades can be attached if desired. In larger shops the universal jaw for a punch would be applicable in many cases.

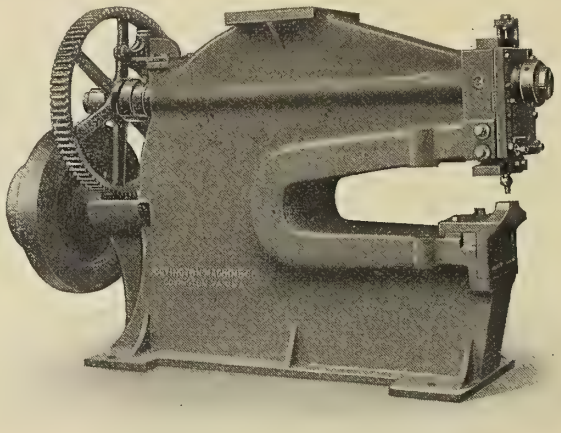


Fig. 2.—Universal Jaw—Punch

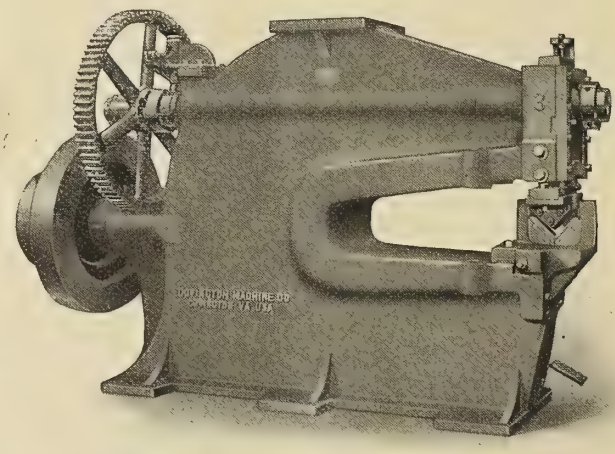


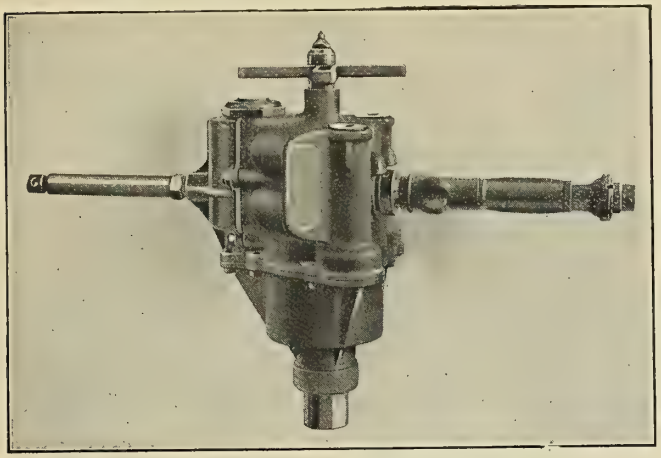
Fig. 3.—Universal Jaw—Angle Shear

Portable Pneumatic Drill for Exceptionally Heavy Work

The "Little David" line of pneumatic drills, manufactured by the Ingersoll-Rand Company, New York, has been increased by the addition of an exceptionally powerful compound geared model, No. 11 SE. This drill is reversible and is adapted to the heaviest flue rolling, drilling, reaming and tapping. It is particularly recommended by the manufacturer for tapping on flexible staybolt work, running in staybolt sleeves, engine valve setting and kindred heavy-duty operations. It is so constructed that it develops full power on the reverse as well as the forward motion. This is pointed out to be of particular advantage in that, after running a flexible staybolt sleeve up tight, the No. 11 SE, due to its unusual power on the reverse motion, will unscrew the sleeve cap. This obviates the necessity for the usual cumbersome wrench.

This drill has the one-piece, gear-timed valves and ball

and roller-bearing crankshaft and connecting rods and general simplicity of construction, which have been features of the pneumatic drills of this manufacturer. It



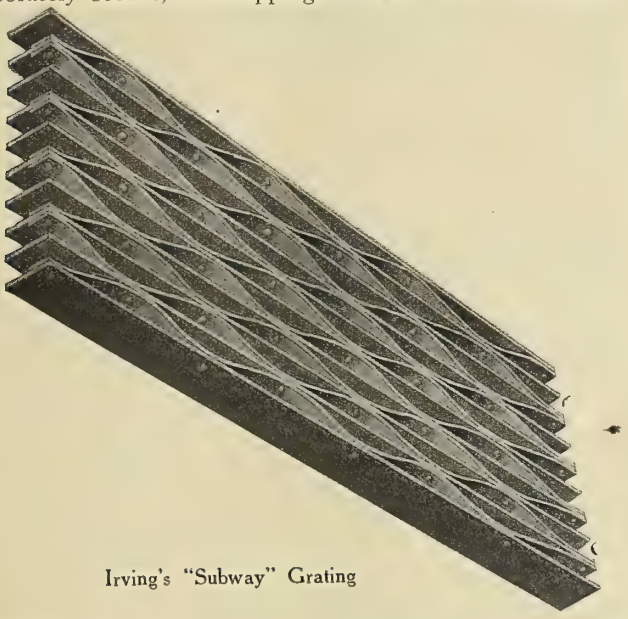
"Little David" Drill for Heavy Work

is ordinarily furnished with a No. 5 Morse taper socket. It operates at a free spindle speed of 100 revolutions per minute.

Irving's "Subway" Gratings for Engine-Room Platforms

The metal grating illustrated, which is manufactured by the Irving Iron Works Company, Long Island City, N. Y., and which was patented on November 26, 1912, under the trade name of "Irving's Subway Grating," is especially adapted for engine-room platforms and other places on board ship where gratings are desirable.

The form of construction, it is claimed, provides an absolutely secure, non-slipping foothold and a maximum



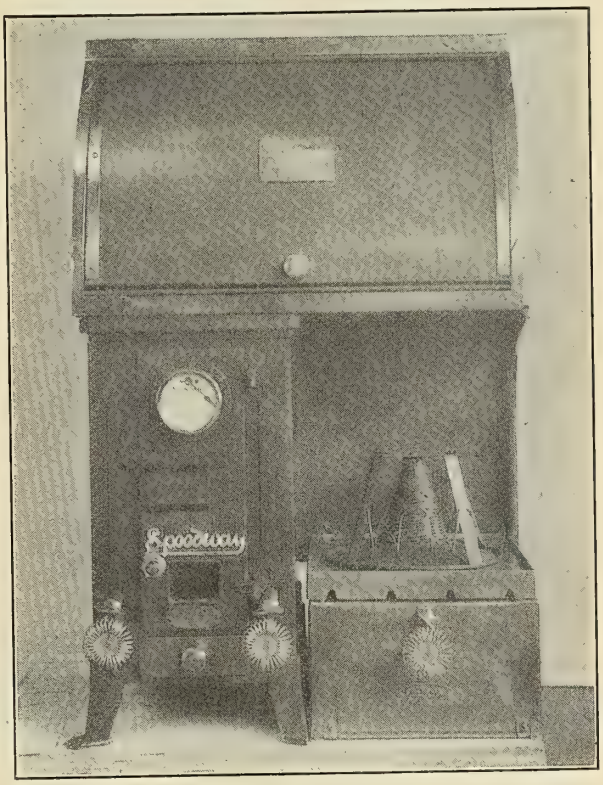
Irving's "Subway" Grating

of ventilation and light. Trucks can be wheeled across the grating in any direction without the danger of the wheels going through and spreading the bars. The truss element of construction makes for extreme rigidity and the full distribution of all loads. Ordinary holes for pipes, vents, etc., can be cut out without additional framing, as the loads will be transmitted around the opening.

This type of grating affords an excellent stair tread, being light, clean and absolutely non-slipping under all conditions. The advantages claimed for it are that it is stronger, smoother and less heavy than checkered steel, cast iron or other ordinary types of metal grating of equivalent strength.

Speedway Alcohol Stove for Yachtsmen

The Gas Engine & Power Company and Chas. L. Seabury & Company, Consolidated, Morris Heights, N. Y., has placed on the market a new type of alcohol stove known as the "Speedway," which involves many improvements. The alcohol burner has been produced in two types—a single and a double burner. The so-called wick is made of such construction as to completely gasify the liquid alcohol before it reaches the burner tips. All burners are so constructed that they can be cleaned from the front of the stove. Leaks through the valve stem opening are effectively prevented by a packing nut with lock nuts. A flash



Speedway Alcohol Stove

pan is so designed that should a valve be left open through carelessness the fuel will not run over and gasify in the compartment, but will pass through an overflow pipe and drain into an auxiliary tank placed conveniently below the stove itself. In this way not only is the overflow alcohol prevented from doing damage, but it is actually saved and poured back into the fuel tank to be used.

This stove has a new type of broiler consisting of a vertical box-like device in which are installed two "Speedway" especially designed burners—one on each side near the bottom. Over these burners are suspended baffle plates so that the heat is uniformly distributed from the bottom to the top of the broiler. On the bottom between the two burners is a drain trough in which the broiling iron is placed in a vertical position. A temperature of 300 to 350 degrees indicated on a thermometer on the door assures a good, quick broiling temperature of 450 to 500 degrees inside. The grease from the broiling meat is drained through a grease drawer beneath the broiler, from which it is recovered without burning and filling the compartment with odors and smoke.

Bernstein Metal Berths

The metal berth illustrated, which is manufactured by the Bernstein Manufacturing Company, Philadelphia, Pa., is of the stationary type for steerage and crew quarters. The stanchions which support the berth are of 1⅜-inch steel tubing equipped with deck flanges or Bernstein flush sockets. Adjustable top flanges, which allow for variation in the height between decks, are also provided, together with malleable iron sockets forming a support for the berth frame. Where necessary cast iron bulkhead brackets are provided in place of the stanchions.

The sides of the berth frames are of 1⅜-inch steel tubing, the ends 1⅛-inch chilled-jointed construction, and



Bernstein Steerage and Crew Berths

the lee rails of 1⅛-inch steel tubing, also chilled-jointed to the frame. The head and foot rails are of ½-inch round iron chilled-jointed to the ends of the berth, and the frame is fitted with National link springs.

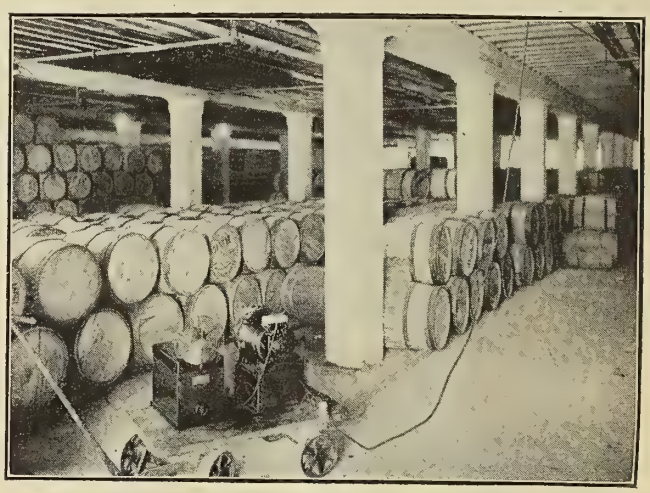
The berth is held in place by flat head steel pins, chilled-jointed to the frame and rests in malleable iron stanchion sockets. The standard size berth is 2 feet 3 inches by 6 feet 3 inches. It is finished regularly in aluminium bronze, but can be finished in any desired color.

In addition to the berth illustrated, the Bernstein Manufacturing Company supplies a complete line of steel equipment for furnishing ships, including folding and stateroom berths, stateroom beds, metal lockers, cabinets and metal furniture.

Sprague Electric Ozonators for Cold Storage Spaces

The difficulties of eliminating odors and the prevention of cross tainting in cold storage spaces for perishable foodstuffs have been accomplished, it is claimed, by the use of ozone properly applied to the atmosphere of the cold storage room. Ozone is simply the oxygen of the air changed into a highly active state by the action of the electric current in an ozonator. In this form it has the remarkable power of destroying by oxidation or burning up the odor-bearing particles of matter floating in the air. This results in the permanent removal of the odor without the necessity of introducing chemicals of any kind.

The Sprague electric ozonator, manufactured by the Sprague Electric Works of the General Electric Company, New York, consists of a small metal box containing the ozone generating tubes and surmounted by an electric fan which forces air through the ozonator and insures an efficient distribution of the ozone. The ozone is formed from the air as it is blown through the electric discharge maintained in the ozone generating tubes. The amount of electricity consumed is equivalent to only about two 40-watt tungsten lamps, and the machines are built for operation on 110-volt alternating current of either 60 or 25-cycle frequency. Where direct current only is available, a small motor generator is supplied to furnish the



Sprague Ozonator in Operation

necessary alternating current for the operation of the machine.

The principal use of these machines is in the deodorization of storage rooms after they have been emptied of their contents in order to prepare them for the reception of other products. With these machines a thorough deodorization of a storage room is accomplished, it is claimed, in about two or three hours.

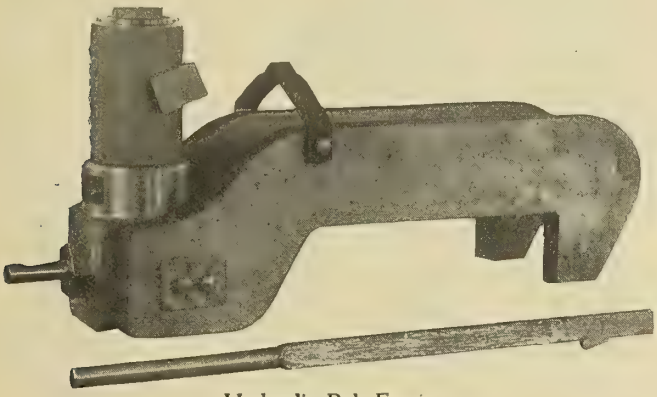
40-Ton Hydraulic Bolt Forcer

The machine illustrated is a small but powerful hydraulic tool designed by the Hydraulic Press Manufacturing Company, Mount Gilead, Ohio, for use in forcing in or out the coupling bolts on steamship shafts where the working space is limited and also for other miscellaneous forcing work which comes up in a navy or shipbuilding yard. The tool's lightness and compactness permit its transportation to the work wherever it may be located. If the work is in an elevated position the forcer can be raised by a small hoist or crane to the work and readily adjusted for the forcing operation. If the work is of such nature that the hook resistance bars are not suitable they may be changed to suit the peculiar requirements for which this forcer is to be used.

The principle by which the pressure is exerted on the ram is the same as that of the hydraulic jack. A maximum total pressure capacity of 40 tons is transmitted on the ram with very little effort on the part of the operator. A rapping pin is provided through the rear of the horizontal cylinder, so that if the bolt does not start with the maximum pressure of the tool a jar may be given on the bolt by a blow on the pin.

The pump and valves are encased in the vertical pump body. The working parts are not exposed. The pump body forms the water or fluid reservoir and the pump

plunger works through the center of this reservoir. The pressure is released from the ram by turning the pump handle over so that the lug on the pump body does not come in contact with the lug on the handle. This permits the pump handle to be forced to a lower position, which



Hydraulic Bolt Forcer

causes a flange on the pump plunger to have a bearing on the discharge check valve stem, thus opening it and permitting the fluid to return to the reservoir.

The ram is soft steel with a hard steel facing, having a travel of 3 inches. The height from the top of the pump body to the base is 19 inches. The distance from the rapping pin to the outer edge of the resistance hooks is 43 inches; from the edge of the resistance hooks to the end of the cylinder the distance is 38¾ inches. The working space between the forcer ram and the face of the hooks is 19 inches.

PERSONAL MENTION

John Carey has been appointed first assistant engineer of the steamer *Adirondack,* of the Hudson Navigation Company, New York.

Webb Cooley, first assistant engineer of the United States tug *General Totten,* has been promoted to the posi- of chief engineer of this tug.

Hermann Winter, assistant to the general agent for the Cunard Steamship Company in the United States, has severed his connection with that company.

William C. Claflin, formerly chief engineer of the steamer *Mary Garden,* has been appointed engineer of the tug *Florence W.,* engaged on barge canal work at Mechanicsville, N. Y.

John Daly, formerly chief engineer of the United States tug *General Totten,* has resigned to accept the position of first assistant engineer on the towing steamer *M. A. Knapp* at Troy, N. Y.

H. Keil, formerly naval architect and technical adviser of the Seattle Construction & Dry Dock Company, Seattle, Wash., is naval architect of the Skinner & Eddy Shipbuilding Company, Seattle, Wash.

G. C. Dohm, draftsman in the scientific department at the New York navy yard, has been appointed assistant naval architect in the scientific department of the Skinner & Eddy Shipbuilding Company, Seattle, Wash.

G. L. Kothny, formerly consulting engineer with the Westinghouse Machine Company, East Pittsburg, Pa., has been appointed consulting engineer and manager of the marine department of the C. H. Wheeler Manufacturing Company, Philadelphia, Pa.

A. C. Brown, vice-president and assistant manager of the Brown Hoisting Machinery Company, Cleveland, Ohio, has been elected general manager of the company, succeeding R. B. Sheridan, who has resigned to accept a position with the American International Corporation, New York City.

OBITUARY

James A. Allan, formerly one of the chief partners of the Allan Steamship Line, died on April 17, at Glasgow, Scotland.

James M. Lincoln, an engineer in the service of the Clyde Steamship Line, died recently at Wareham, Mass., at the age of sixty-two.

Captain William Jamieson, one of the oldest captains on the Great Lakes, died recently at his home in Milwaukee, Wis., at the age of eighty-five years.

Erasmus D. Leavitt, a graduate of the Naval Academy and a prominent mechanical engineer, died at Cambridge, Mass., on March 11, aged seventy-nine years.

Thomas Ward, a veteran marine engineer of Albany, N. Y., died recently, after a lingering attack of muscular rheumatism. Mr. Ward owned and operated several tugs at Albany and Troy, N. Y.

Peter Deitz, a popular engineer at Albany, N. Y., died recently at St. Peter's hospital, Albany, of Bright's disease. For several years Mr. Deitz was in the employ of the Davis Construction Company, Albany, N. Y.

Robert McCreery, head of the harbor lighterage business under the firm name of John McCreery's Son, and a member of the Steamship Board of Navigation, died recently at his home in New York City, aged sixty-four years.

Edward J. Garvey, a veteran marine engineer, died at his home in Watervliet, N. Y., on March 20. Up to the time of his retirement Mr. Garvey had been employed on the ferries at Troy, N. Y., and was formerly employed on harbor craft in New York harbor.

Captain Worth G. Ross, who retired as chief of the United States Revenue Cutter Service in 1911, died at his home in New Bedford, Mass., on March 24 at the age of sixty-two. Captain Ross became chief of the Revenue Cutter Service in 1905 and held this position until his retirement on account of ill health in 1911.

Darwin Almy, president of the Almy Water Tube Boiler Company, Providence, R. I., died recently at his home in Providence. Mr. Almy's successor as president of the company is Frank D. Almy, for many years superintendent of the company. Charles F. H. Almy is vice-president and secretary of the company, and Walter S. Almy, treasurer.

Joseph A. Sedgwick, treasurer of the Fore River Shipbuilding Corporation, Quincy, Mass., died at his home in Quincy on April 14, aged forty-five years. Mr. Sedgwick was formerly employed in the purchasing department of the Bureau of Construction and Repair of the Navy Department and became associated with the Fore River Shipbuilding Company in 1904 as auditor of the company.

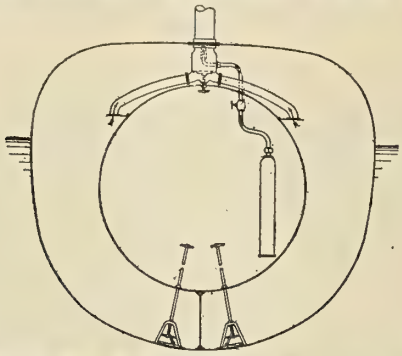
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,161,484. SUBMARINE VESSEL. CESARE LAURENTI, OF TURIN, ITALY, ASSIGNOR TO SOCIETÀ FIAT-SAN GIORGIO, OF SPEZIA, ITALY.

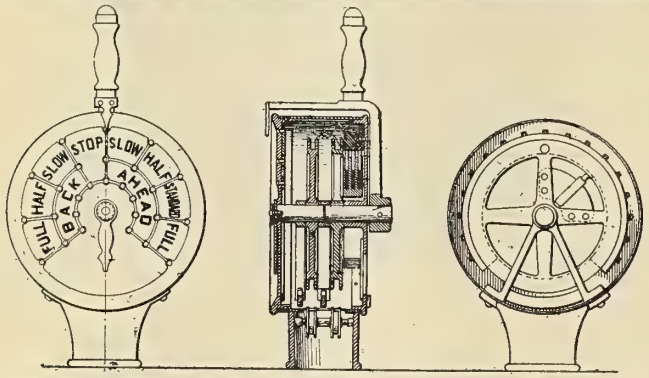
Claim.—In a submarine, ballast tanks, pipes leading from the ballast tanks for the escape of air therefrom when it is desired to admit water for submergence purposes, and an injector located in the air escape pipe



for accelerating the flow of air from said ballast tanks and thereby accelerating the inflow of water and the submergence of such vessel.

1,163,191. SHIP'S TELEGRAPH. FRANK W. WOOD, OF BROOKLYN, N. Y., AND HARRIS LANING, OF PETERSBURG, ILL.; SAID WOOD ASSIGNOR, BY MESNE ASSIGNMENTS, TO CHARLES CORY & SON, INC., OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

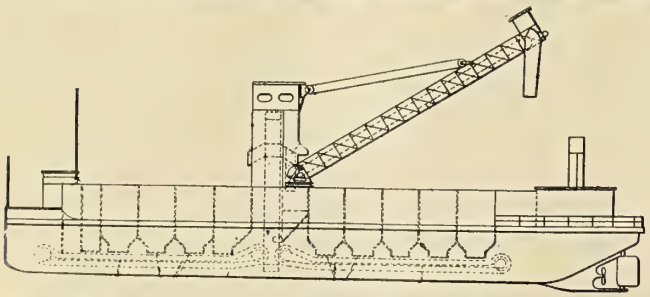
Claim 1.—In an apparatus, the combination of mechanical transmitting signal means having a chain, an electrical transmitting signal means having a plurality of fixed independent electrical contact terminals, and



a fixed common terminal, of a shaft, a pulley keyed on said shaft adapted to receive said chain whereby to actuate said mechanical transmitting means, a plurality of contact fingers mounted on said pulley and rotatable therewith and adapted to engage said fixed terminals, one of said contact fingers being adapted to engage with said common terminal, and a handle on said shaft for turning the same and the pulley whereby to positively actuate both of said signal means simultaneously. Two claims.

1,164,934. FUEL LIGHTER. RAYMOND W. DULL, OF AURORA, ILL., ASSIGNOR TO STEPHENS-ADAMSON MFG. CO., OF AURORA, ILL., A CORPORATION OF ILLINOIS.

Claim 1.—A boat divided into compartments forming bins, conveyors for receiving the contents of the bins, means for controlling the dis-



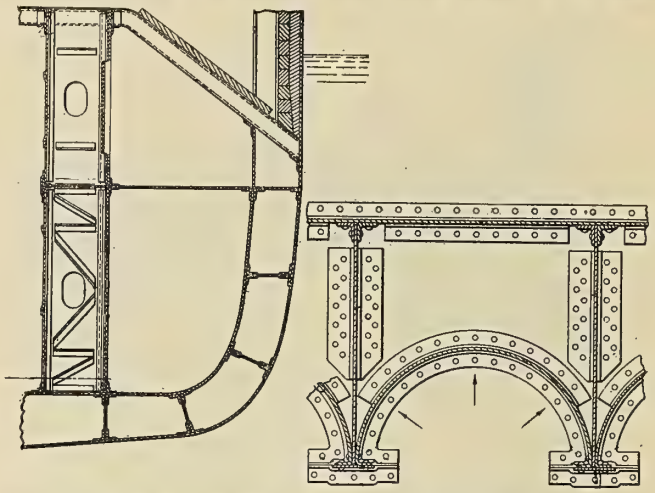
charge of the contents from the bins, an elevator for receiving the contents from the conveyors, the ends of the conveyors overhanging the transversely arranged lower portion of the elevator, a boom provided with a conveyor for receiving the contents from the elevator, and a spout for the end of said boom, whereby the contents of any bin can be discharged at either side of the boat. Six claims.

1,162,132. DAVIT. JOHN CAMERON, OF NEWARK, N. J.

Claim 3.—A davit comprising vertically arranged rotatable davit arms, supporting means for said arms, locking means on the arms for engaging the supporting means to lock the arms in predetermined positions, and means on said support to engage the locking means to automatically cause the locking means to assume a locking position. Sixteen claims.

1,164,814. ELASTIC BULKHEAD. WILLIAM HOVGAARD, OF BROOKLINE, MASS.

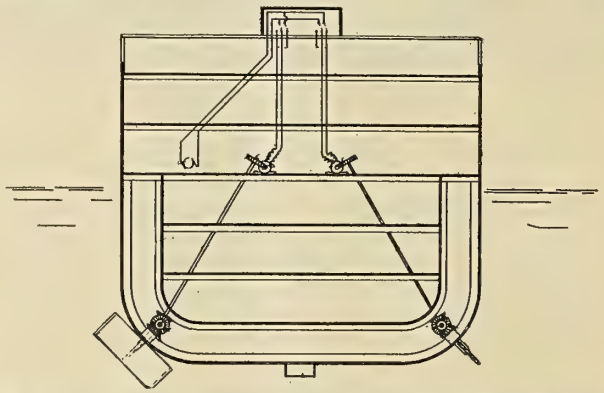
Claim 1.—A bulkhead embodying in its construction a series of fixed supports, a wall of substantially plane plating secured to the inner



faces of said series of supports, and a second wall of plating secured to the outer edges of said series of supports, said second wall being curved inwardly intermediate said supports. Five claims.

1,164,817. SHIP BRAKE. JOHN H. HYDE, OF TACOMA, WASH.

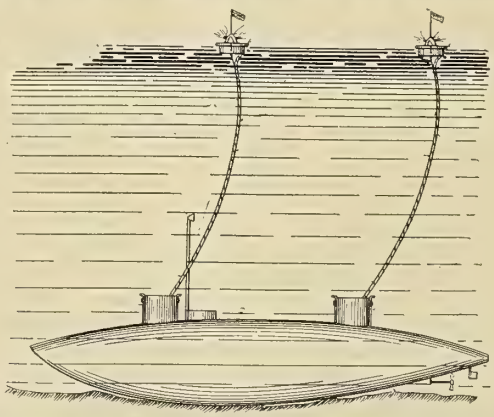
Claim.—The combination in a ship of a series of longitudinally extending bilge keels of box construction fixedly secured to the ship in coaxial arrangement and having free spaces therebetween, correspond-



ingly shaped brake plates mounted in said free spaces, said brake plates being of the full thickness of said keels, pivots secured to said brake plates at their longitudinal centers and passing through the skin of the ship, and positive means for turning said brake plates arranged to move the same at right angles to said keels when so desired.

1,169,128. APPLIANCE FOR VESSELS. EDWARD F. CRANE, OF HOBOKEN, N. J., ASSIGNOR OF ONE-HALF TO ARTHUR J. GRYMES, OF EAST ORANGE, N. J.

Claim 1.—The combination with a vessel, a container mounted on its hull, the bottom of the container and the hull having registering openings with packing therein, a cable having its lower end secured in the



hull and its body passing through one of said openings and stored within the container, and a tubing stored within the hull and its body passing through the other of said openings; of buoy normally closing the upper end of the container, the upper end of the cable being attached to said buoy and the upper end of the tubing passing through said buoy, and means within the vessel for releasing the buoy from the container. Five claims.

INTERNATIONAL

MARINE ENGINEERING

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Naval Training for Civilians

A NAVAL training cruise for civilians, authorized by the Navy Department of the United States, will begin on August 15, and last until September 18. The course of training is to be given on board reserve battleships, and citizens of the United States who are between the ages of nineteen and forty-five, and who are physically fit, will be recruited by naval districts and the ships will be allotted according to the number of recruits accepted in different districts. This commendable movement will give an opportunity to those who have had experience in marine engineering to render valuable service to their country. During the final week of the course residents of the district who own yachts or motor boats which would be useful as auxiliaries in time of war, will be given an opportunity to operate in conjunction with the ships. Any of our readers who are interested in this movement can obtain full particulars by writing to the Navy Department, Washington, D. C.

The Shipping Bill

ALTHOUGH the Administration shipping bill has been passed by the House at the time of going to press with this issue, it remains to be seen what disposition of this measure will be made by the Senate. If no other result is accomplished, the proposal to create a United States Shipping Board should become a law. Under existing conditions there is so much vagueness and uncertainty as to what should be done to place the American merchant marine on a sound basis for permanent growth in competition with the world's shipping that means should be provided immediately for making a thorough investigation and study of the actual needs of American shipping and for the examination of the navigation laws of the United States, so that necessary recommendations can be made to Congress for the revision of rules and regulations relating to shipping. With a United States Shipping Board, composed of the best qualified men in the marine field, empowered to work out on common sense lines a systematic and feasible method of fostering shipping, many of the difficulties in the marine field would soon be eliminated. If such a board is provided with an appropriation for the purpoe of building, purchasing, leasing or chartering a limited number of vessels to meet immediate emergency needs and to encourage the development of foreign commerce, it is not to be presumed that such an arrangement would work to the detriment of private ship owners. If such a board is to be the guiding hand in the future development of the American merchant marine, surely it can be entrusted to exercise sound judgment in the initial stages of establishing an efficient steamship service and to look after the best interests of American ship owners in the future. The bill should be passed.

Standardized Ships

NUMEROUS proposals have been made in recent months by shipbuilders in the United States for the systematic building of standard types of merchant cargo vessels. These proposals have been made, of course, with a view to securing the rapid and economical construction of a comparatively large number of vessels to meet the urgent demand for new tonnage, which has been prevalent since the war began. It is believed that by standardizing construction the time and cost of building can be materially reduced. If the proposals had come from the ship owners, they probably would have met with immediate success, but it has always been the case that ship owners have refused to surrender their personal preferences and ideas to standard designs, and no matter how successful a type of vessel may be, it is difficult to convince different owners that their requirements will be amply served by a standard design without modifications, which in many cases are needless, and which eventually increase the cost of construction. The same difficulty prevails, not only in hull work, but especially in machinery installations and fittings and equipment. With so many different types of propelling and auxiliary machinery opening up possibilities of varying degrees of economy in operation, it perhaps is too much to expect that standards of machinery would be advisable. In a great measure, however, standardization of design and construction in hull work, and particularly in fittings and equipment, could be worked out profitably.

Economical River Transportation

EXPERIMENTS to determine the most economical method of transportation of heavy freight by improved types of boats on the Mississippi River have been provided for by an amendment incorporated by the House of Representatives in the Rivers and Harbors bill. Several years ago Congress appropriated half a million dollars to be used by the Engineer Corps of the United States Army for designing and constructing experimental towboats, barges and loading and unloading facilities for towing and delivering freight along the Mississippi River and other Western rivers. Although only a small part of this appropriation was used for this purpose, a voluminous report was returned to Congress by the Commission of Army Engineers appointed for this purpose. This Commission investigated thoroughly the inland navigable waters of Europe and by its investigations both at home and abroad was able to make recommendations as to the most suitable types of boats for economical speed for upstream towing, the most economical types of barges and the class of propelling machinery for river boats. In general, two types of boats were recommended, the stern wheel and the tunnel stern screw propeller boat. The

Army Engineers are now authorized to use a portion of the unexpended balance of the earlier appropriation for making such experiments with these two types of boats, as will fully demonstrate the economy in the transportation of heavy freight on the Mississippi River. These experiments are to be carried out at varying stages of the river and are to be completed within two years.

Valuable as the work of the Army Engineers has been in this direction, it has yet failed to solve the difficulties of western river boatowners in developing river freight traffic. It does not appear just how much gain in economy can be expected by improving old methods of river transportation, or if the reduced cost of operation alone would make such development profitable.

Fire Protection on Steamers

The Board of Supervising Inspectors of the United States Steamboat Inspection Service has adopted a rule approved by the Secretary of Commerce requiring that steamers more than 150 feet in length, carrying passengers, or passengers and freight, contracted for after June 30, 1916, shall have the funnels protected by an iron or steel trunk or casing, extending through all decks above the connection of the funnels with the boilers or breechings. If the engine room compartment extends above the main deck, it is to be protected through all decks by iron or steel bulkheads and by an iron or steel trunk extending through the upper deck. After December 31, 1916, all steamers carrying passengers, which also carry freight upon the main deck, which is accessible to passengers or crew, are to have the main deck freight space protected on the sides and overhead by sheathing of sheet steel or iron, or of a substantial non-combustible material; or, in place of this, the space is to be protected by an efficient overhead water sprinkling system. The crew and passenger accommodations located below the main deck on steamers regularly engaged in the passenger traffic shall be equipped with an efficient overhead water sprinkling system. These requirements can be readily met, and, in fact, many vessels of the class referred to are already provided with efficient protection of this kind. It is a necessary provision and should have been made long ago.

The Future of the Marine Oil Engine

BY JOHN F. WENTWORTH

The oil engine unquestionably has a great future before it, but in order that this future may be realized in the actual commercial development of this type of motive power certain points must be carefully kept in mind.

The first point to consider is that the oil engine differs from the "gas engine" only in its fuel and means of using this fuel. There is no thermodynamic theory underlying this engine, which is different from the gasoline (petrol) engine, other than the points brought up by the use of such a fuel as is practical for use in commercial vessels in competition with coal-burning vessels.

The briefest possible consideration of this problem is by first taking up the matter of economy, then the fuel which will make this economy possible and the fuel valve which will make it possible to use this fuel.

Economy

In considering the matter of economy, the relative merits of the two and four-cycle types of engine are matters of prime importance. It is generally conceded that the two-cycle has about 10 percent lower efficiency than the four-cycle. This means that power for power the two-cycle uses 10 percent more fuel than the four-cycle. This comes about probably from the frictional loss in the scavenging cylinders and from the fact that a part of the expansive energy of the fuel is lost through the open ports at the end of the working stroke. It is not the purpose to take up this controversy at this place. Space forbids. This difference in efficiency exists and it must be offset by some other feature such as compactness, lightness or cheapness of manufacture, if the two-cycle engine is to be adopted.

One point of prime importance in both types of engine is the fact that about 10 percent of the brake horsepower is consumed in the air compressors for high pressure air. This is a loss which can be properly considered here. The prime use of this high pressure air is to feed the fuel into the cylinder. If it be possible to cut down this loss by 50 percent, then a saving of 5 percent of the fuel used in either type of engine can be accomplished., It is certain that a part of this saving at least can be made by using hot injection air for fuel feeding. In the beginning of this work, the fuel valve was water-jacketed very carefully. This results in assuring that the injection air shall be very cool. The question of how far this should be carried is one of the points for manufacturers to consider and for prospective purchasers to investigate, since it has a very direct bearing upon the performance of the engine.

Another point affecting the economy of the engine is the low mechanical efficiency of the oil engine. This is due no doubt to the high pressures used in the present types of engine. If it be possible to reduce these present pressures, then the mechanical efficiency will rise with the result of greater profits to the purchasers of this type of plant. That this is possible has been demonstrated by actual experiments where heavy fuel has been fired in a cylinder where the pressure was not over 150 pounds in place of the 500 pounds at present commonly used in the oil engine.

In this consideration, to call attention to the great gain in cargo carrying capacity caused by the use of the fuel oil engine would be out of place as an old story.

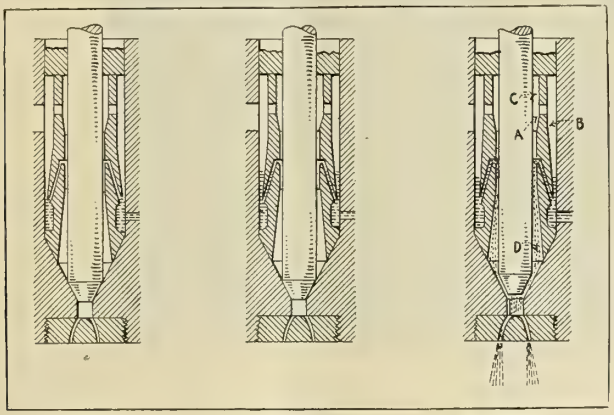
The matter of fuels and fuel valves has been taken last as the part of universal interest to all. The matter of savings in injection air and in reduced pressure are mentioned simply as subjects for individual study and consideration. The matter of fuels can be grasped by all regardless of technical training.

Fuel

Recently the agent of an oil engine advised in the engineering press against the use of the extreme low grades of fuel for the oil engine. My purpose is to try to show the folly of such advice. We see the world today trying to catch up with the demand in the matter of gasoline (petrol). It is my purpose to warn prospective purchasers of oil engines from being caught in the position of the automobile users. The gas oil is a refined product. It is not used in steam plants for fuel. In other words, it is the gasoline (petrol) of the oil engine. When gasoline (petrol) was first used for power purposes it was a by-product from the production of kerosene (paraffine). For years it was reasonable in price till the rapid production of gasoline (petrol) engines has caught up with the production and made the price almost prohibitive. The same will happen with any fuel which is of use only for the oil engine. The oil engine which cannot be caught by the high price of fuel is the engine which uses the same fuel which is used by the steam plant. Users of oil engines, you can only rest assured of the future so long as you are using the same fuel

which is being used by the steam plants. Owing to the fact that the steam plant has an efficiency of around 10 percent the oil engine with its 30 percent efficiency will be safe from a pinch in price of fuel so long as this is the condition.

The only sensible difference between the gas oil and the steaming oils lies in the viscosity. This makes it more difficult to atomize. Would it be worth while for the motor ship to buy steaming oil and refine it or treat it so that a form of gas oil could be made? It certainly would be, provided that the expense of the operation would not be prohibitive. This process simply calls for the fuel to be heated. Oils of an asphaltum base, which is the class to which the steaming oils belong, increase their Baumé one degree for about every 15 degrees rise in temperature. This means that a fuel of 19 Baumé, which would be a very low grade fuel, if heated to about 300 F. will have a Baumé of 33 degrees. This will compare very favorably with gas oil. After this heavy oil



Injection stroke completed. Valve just closed | Fuel pump stroke completed. Valve still closed | Working stroke. Valve open, feeding fuel

Diagrams Showing Operation of Hesselmann Fuel Valve

has been treated in this manner it will in every way be the equal of gas oil so long as this temperature has been maintained.

What is the present advantage in the use of this heavy fuel? The fuels have practically the same calorific value per pound. Fuels are bought by the bulk. Oil of 19 Baumé has a specific gravity of 0.94. Oil of 33 Baumé has a gravity of 0.85. The difference in price between steaming oil of 0.88 gravity and gas oil of 0.85 gravity is about 15 percent in carload lots. The difference in the case of the heavier fuel will be much greater. Besides this difference in price there is the additional advantage due to the fact that a gallon of the heavy fuel will do more work than the same amount of light fuel.

This shows an advantage of over 50 percent at present, besides the assurance against a pinch in price later. Is it worth taking a little trouble for? Can you buy an engine which will use this fuel? It certainly is worth the trouble to use this heavy fuel. You can get the engine if you ask for it. Naturally the builder will advise against this type of engine because its construction is more difficult in all parts pertaining to the fuel handling. No oil engine manufacturer will deny that he can build this type of engine. If he does, go to a builder who can. There are engines in operation to-day which are using this type of fuel. The Palo Alto engine (an engine bought and installed in the municipal plant in Palo Alto, Cal.) has been running on this oil for a year with good results. The fuel used in this engine has been of 15 Baumé.

Motor ship owners, do you want to use this cheap fuel? If you do, demand it in your guarantee and you will be surprised at the number of firms which will be willing to meet this condition.

Fuel Valves

The various types of fuel valves have been described in print so that their elements are familiar to all. It will be more to the point to consider what to look for in a good fuel valve. The fuel valve to handle the oil the owner wants to use must be equipped to handle sluggish flowing oils. This type of oil can be improved by heating, but at the same time our valve should be the best possible. In the original type of fuel valve the oil was delivered into a space broken up by a series of baffles. When the fuel valve was unseated the air rushing through this tortuous passage was able to break the oil up and deliver it in a fine spray. To secure perfect results with a valve of this sort using the heaviest grade of fuel is very difficult, if not impossible.

The fuel valve is the oil engine's carbureter. It must be perfectly reliable. To be able to get this result, it is only needed to study the action of the familiar nasal atomizers. The can draw free flowing oil and deliver it in the form of a suitable spray. If one takes a standard nasal atomizer and fills the glass with gas oil, it will be found that a perfect spray can be obtained. If we substitute in the household article, heavy oil in place of the light oil, it will be found that no spray can be produced. What is the reason? Simply that the siphonic action is not strong enough to lift the heavy oil. This suggests to us that any fuel can be sprayed if we force a stream of fuel into a stream of high pressure air at right angles to this air. In this way the action is absolutely positive.

One fuel valve of this type, the Hesselman fuel valve, is at present on the market. In the figure showing the operation of this valve the different parts of the passages are lettered. As long as the valve is closed the air pressure at *A*, *B* and *D* is equal. As soon as the valve is unseated owing to restricted passage from *A* to *D*, while the pressure in *A* and *B* are equal, the pressure in *D* is reduced. The available pressure forcing the fuel into the stream of air will depend upon the size of the passage into the cylinder, the size (cross sectional areas) of the restricted passage, and whether the fuel passage from *B* into the restricted passage between *A* and *D* is near to *A* or to *D*. The only objection to this valve is that once it is built it is suited to a certain condition by the proportions of valve. The fuel is delivered at right angles to a moving stream of air and it seems reasonable to think that any fuel can be used in a valve of this type. This valve does not act on the siphon idea, but on the principle of a positive pressure behind the oil forcing it into the stream of air. This element of positive pressure behind the fuel seems to be the most desirable element in the fuel valve.

Summary

Finally, in considering different types of engine for installation, do not be misled by the great saving at present in the use of any type of oil engine. Remember that fuels which are cheap now may be dear before your engine is scrapped. Demand an engine which will use the sort of fuel which is used under the steam boilers. If you decide to install a two-cycle engine, remember that at the start you are giving a 10 percent handicap to your competitors who use a four-cycle engine, and make the builder show you very clearly how you are to make up this 10 percent handicap.

When these questions are settled to your satisfaction you can not be far wrong in your selection of the engine for your fleet.

FROZEN BEEF FOR EUROPE

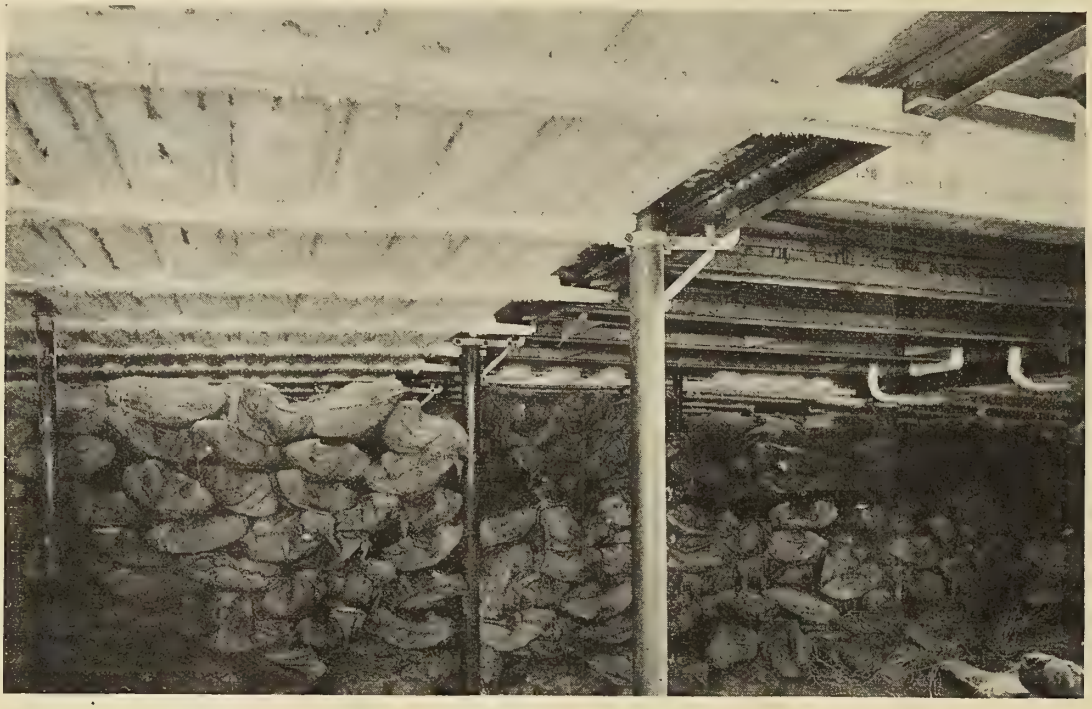


Fig. 1.—Cargo Space for Frozen Meat

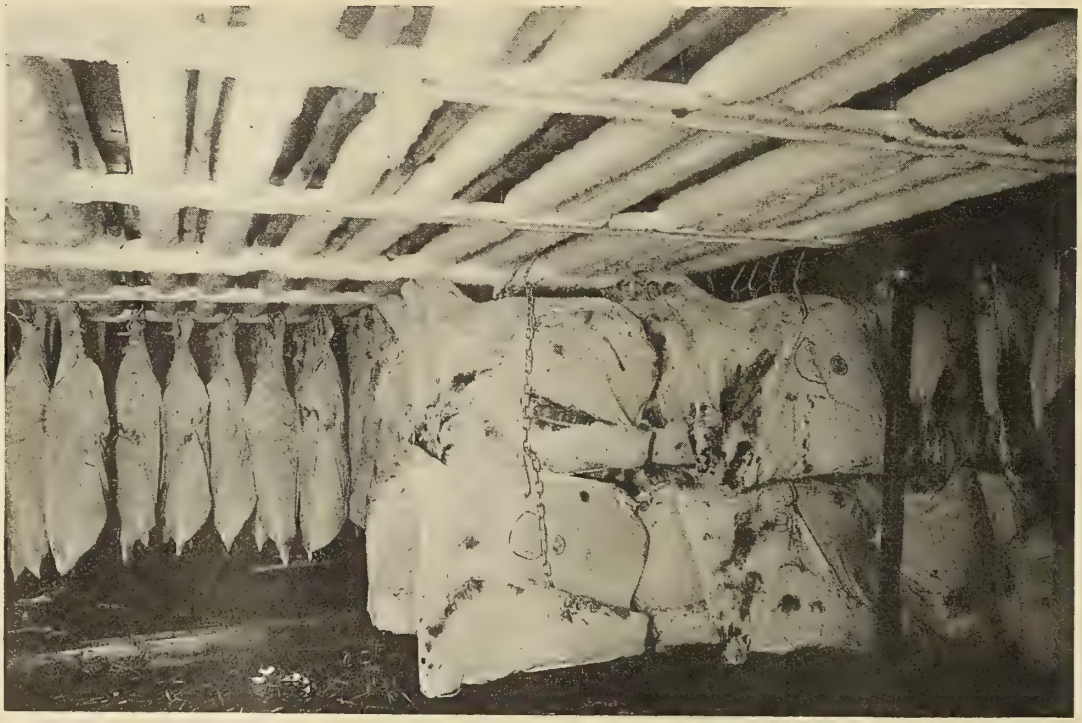


Fig. 2.—Cargo Space for Chilled Meat

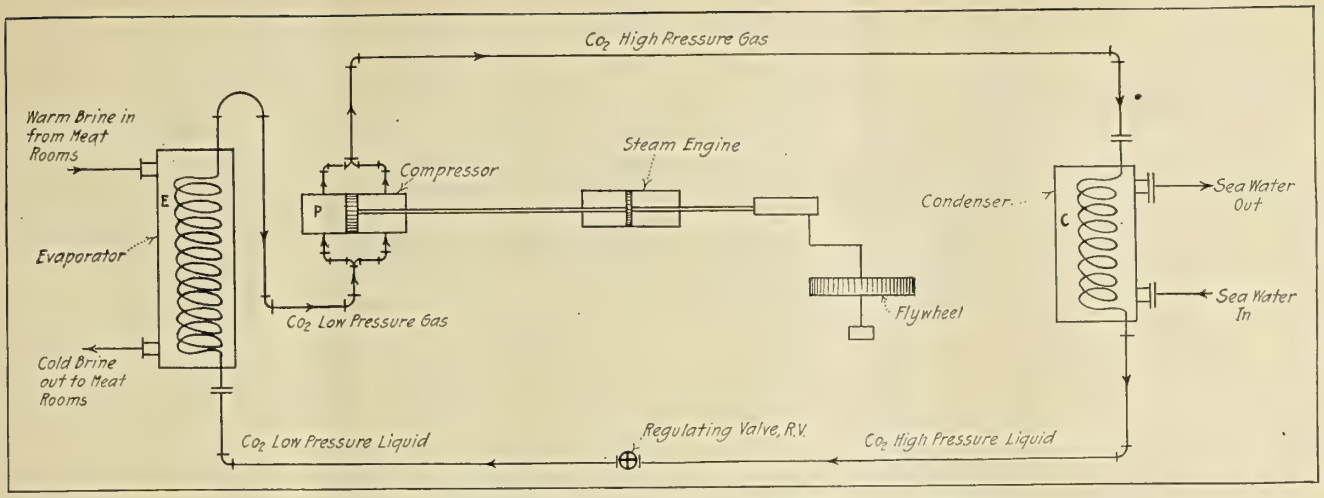


Fig. 3.—Diagrammatic Sketch of Carbonic Acid Refrigerating Plant

Frozen Beef for Europe

S. S. Procida Fitted With Carbonic Acid Refrigerating Plant

AT the end of February, 1916, invitations were received by shipping firms, builders, naval architects and marine engineers to view the completed installation of carbonic acid refrigerating machinery installed by the Shipley Construction & Supply Company, Brooklyn, N. Y., on the steamship *Procida* for the Navagazione Generale Italian of Genoa, Italy, her owners. A large number of persons visited the vessel and viewed this interesting installation and for the benefit of our readers who were unable to visit the ship we are giving the following description:

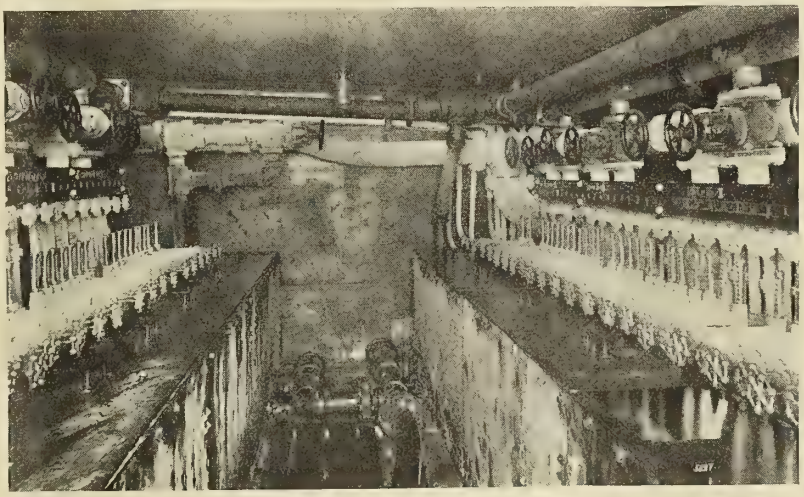


Fig. 4.—Delivery and Return Valves

The equipment of this vessel is a stepping stone in American marine progression, as she has the first large installation of carbonic acid marine refrigeration machinery built and installed in this country for a vessel to carry exclusively refrigerated meat in all her cargo spaces. We trust this will indicate to American and foreign owners and builders that they can now get satisfactory installations of this kind in the United States.

The following is a brief description of the manner in which a carbonic acid plant is used to refrigerate insulated space on board ship for the carriage of frozen meat by the *"brine system."*

The cooling system can be considered as consisting of two complete units.

First—The brine-cooling system, which is used to cool the meat chambers by means of a circulation of cold brine through pipes placed in the chambers. The cold brine is pumped from evaporator tanks by steam-driven pumps and is forced through the pipes in the cold chambers. The brine, in this circulation, is raised in temperature and the meat spaces cooled by an equivalent amount so that the brine returns to the evaporator at a higher temperature than that at which it was drawn from the evaporator by the pump. In order to cool the brine in the evaporator the carbonic acid system, which constitutes the second part of the plant, is used. This is a little more complex in its operation and arrangement, but to make the matter clear, attention is called to the diagrammatic sketch of the system shown in Fig. 3.

Second—The carbonic acid system consists of four principal parts—an evaporator (marked *E*), compressor pump (marked *P*), condenser (marked *C*) and regulating valve (marked *RV*). The carbonic gas, usually indicated by its chemical formula CO_2 and sometimes called carbon dioxide or carbon dehydrate, is contained within the pipes placed in these different parts, and the operation of the cooling cycle is as follows:

Imagine the carbonic acid to be stored as a liquid in the coils in the condenser tank *C*. The regulating valve *RV* is opened slightly to allow a small amount of carbonic acid to flow from the condenser to the coils in the evaporator tank *E*. It is obvious that this liquid would not flow as required unless the pressure in the evaporator

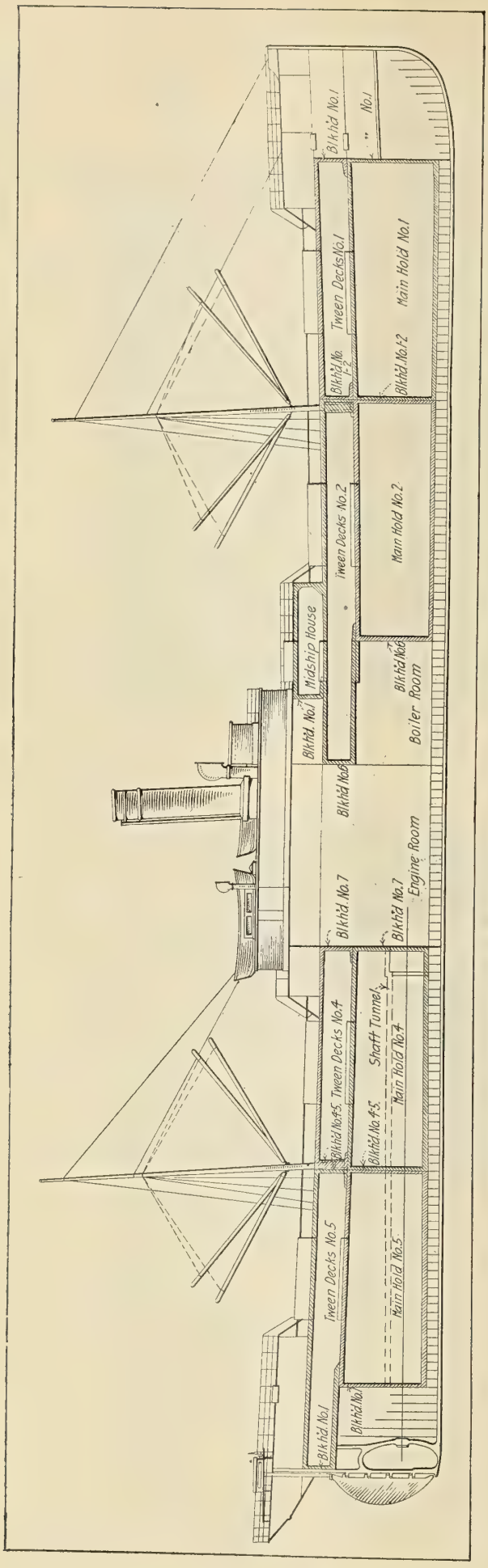


Fig. 5.—Inboard Profile of S. S. *Procida*, Showing Insulated Holds and 'Tween Decks Cargo Spaces

coils were lower than the pressure in the condenser coils; besides, the liquid will require a drop in pressure to cause the flow. The function of the compressor pump *P*, therefore, is to maintain a pressure in the coils *E* lower than in the coils of the condenser *C*. The CO_2 is still in the form of a liquid and it will not assume the form of a vapor unless heat equivalent to its latent heat of evaporation is imparted to it from an outside source. This is exactly the same as converting water into steam in a boiler by means of heat applied externally from a furnace. This source of external heat is the brine in the evaporator tank surrounding the carbonic acid coils contained therein, which, being at a higher temperature than the carbonic acid liquid, by the transfer of its heat converts the CO_2 from a liquid to a gas and the brine is itself reduced in temperature by an equivalent amount.

We now have the carbonic acid in the evaporator in the form of a gas and in order to utilize it again in our cycle of operation it is necessary to convert it back again to a liquid. This is accomplished by means of a condenser *C*, the operation of each being as follows:

The compressor *P* draws the carbonic acid gas from the evaporator coils *E* at a low temperature and pumps or compresses it from the lower pressure in the evaporator to the higher pressure of the condenser and discharges it into the coils in the condenser, still in the form of a gas.

In order to convert it from a gas to a liquid in the condenser it is necessary to abstract from it an amount of heat equivalent to its latent heat of liquefaction. This is exactly analogous to the process in a steam condenser where steam is condensed into water by means of an outside circulation of sea water.

The condenser coils *C* in which the carbonic acid is now located in the form of a gas is surrounded by a circulation of cold sea water, and this cools the gas and converts it into a liquid, the water becoming slightly heated and discharged overboard. The carbonic acid is now in the form of a liquid in the condenser coils *C* and is ready again to be passed through the regulating valve *RV* back to the evaporator coils in continuation of the cycle already described.

From this it will be seen that the carbonic acid is in constant circulation from the condenser through the regulating valve to the evaporator and is forced back by means of a compressor pump into the condenser again. Furthermore, it will be necessary that it does not at any time come in contact with the brine or sea water, there always being the thickness of the pipe intervening between these different substances. Similarly, the brine circulation described as the first part is also a continuation of the cycle of operation, the brine being drawn from the evaporator, discharged through the cooling coils in the meat spaces back to the evaporator again, and so on.

The brine cooling coils in the rooms are shown in Figs. 12 and 13, and the evaporator and condenser tanks and coils (which are exactly similar to each other) are shown in Figs. 9 and 10, respectively. The compressor pump, which is driven by a suitable steam engine, is shown in Fig. 3.

The steamship *Procida* is a spar deck, single screw steel vessel of 3,928 gross tons, built in 1901 in Italy, and is 359 feet 6 inches long, 45 feet 3 inches beam and 18 feet molded depth, provided with triple expansion engines with cylinders 23½ inches, 39½ inches and 64½ inches diameter by 43½-inch stroke of 369 nominal horsepower. There is a large bridge house amidships and four holds and 'tween decks, also a forecastle and poop and five main hatches. All machinery is placed amidships.

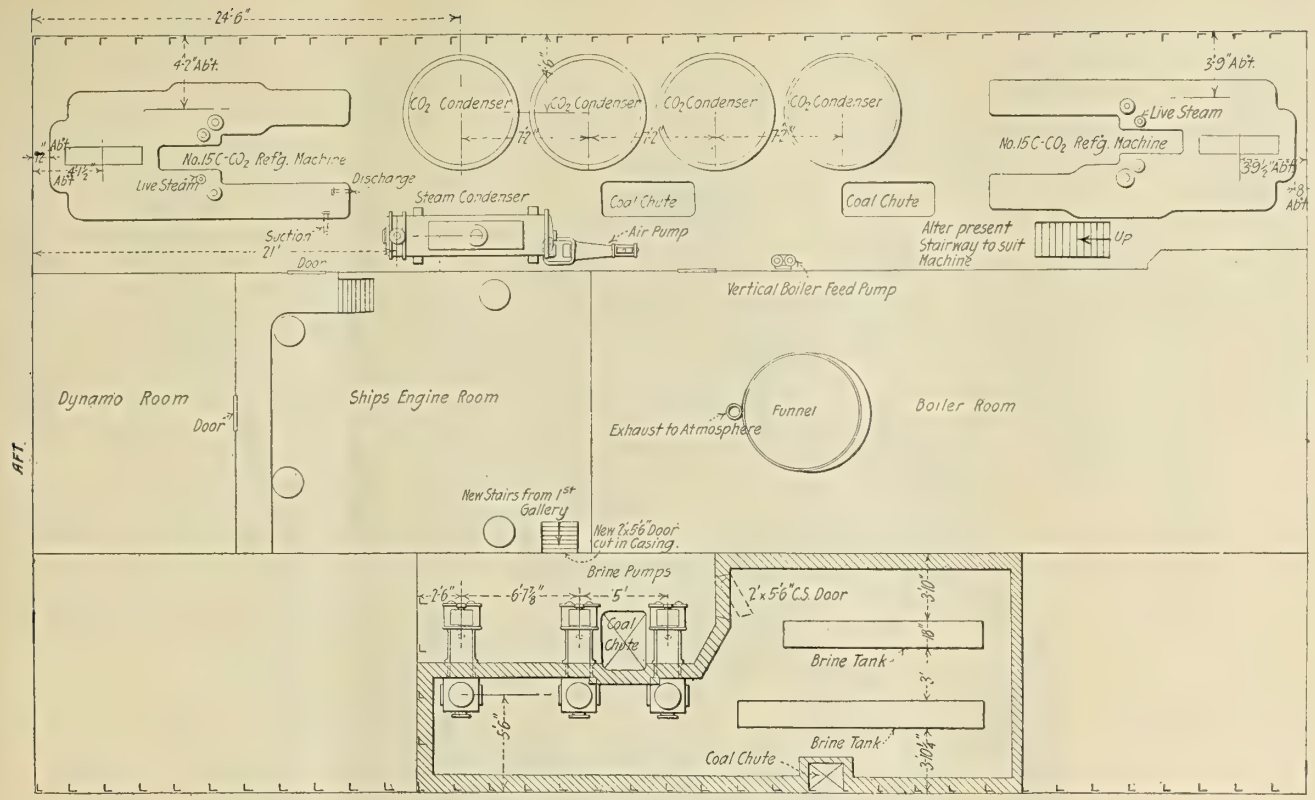


Fig. 6.—General Arrangement of Refrigerating Machinery

As can be seen from the general arrangement plans of the vessel (Fig. 5) each of the nine refrigerated compartments is completely insulated and fitted with insulated hatches. This plan shows that the vessel has the Nos. 1, 2, 3, and 4 lower hold and Nos. 1, 2, 3, and 4 'tween deck spaces and the bridge house space insulated and piped for the carriage of frozen meat cargoes. The insulated capacity of the spaces is 210,000 cubic feet. The *Procida* actually carried 2,100 tons of frozen beef on her first voyage from New York to Italy, where she delivered her cargo in prime condition at a temperature of 10 degrees F. on March 22, 1916.

General Arrangement

The refrigerating machinery is placed in the midship house on each side of the engine room and boiler casings in what was originally bunker space. The machinery is placed on the port side and the brine pumps, the brine return tanks and all their connections on the starboard side. The evaporators are placed on the starboard side at the forward end of the No. 3 'tween decks and below the level of the return tanks and brine pumps.

Fig. 6 shows the arrangement of the refrigerating machinery; with the exception of the evaporators, and Fig. 7 shows a trim plan which will be of particular interest to naval architects, as it shows the pains taken by the contractors to have the machinery so placed as to balance the moments on opposite sides of the vessel. The port weights are 76 tons and the starboard weights 89 tons, but the port moments are 1,156 foot-tons and the starboard moments are 1,157 foot-tons, thus maintaining practically perfect equilibrium.

From Fig. 6 it will be seen that the refrigerating machinery consists of two 50-ton CO_2, double-acting, duplex compound steam-driven machines at the fore and aft ends of the machinery space, respectively, with the four-circular carbonic acid condensers, the independent surface steam condenser and independent air and feed pumps placed between the machines. Through the engine room two coal chutes pass to the wing bunkers below.

The refrigerating engine room has seven side lights and two overhead skylights, with doors for access from the main engine room and bridge deck respectively. This style of machinery construction and arrangement was rendered necessary by the low deck heights and by the necessity of being able to remove the condenser coils through the deck above, their location being such that they clear the overhead waterways and superimposed deck houses.

The three brine pumps have each a capacity of 500 gallons per minute at an easy speed—two working together, circulating 1,000 gallons of brine per minute, perform the duty for the whole vessel. The advantage of a large circulation of brine lies in the fact that it enables an equal circulation to be maintained throughout all the ship's cooling circuits with both the delivery and return valves full open. It has the further advantage of performing the refrigerating duty required with a less difference in temperature between the brine in and out and it results in a more even temperature throughout the cold spaces and a higher initial brine temperature. This last feature enables more work to be performed by the refrigerating plant per unit of driving power and is consequently conducive to direct economy in operation. The exhaust steam lines from the brine, water, air and feed pumps are so arranged that all the pumps are very effectively compounded and produce maximum economy in operation.

It is interesting to note the manner in which the brine pumps have been arranged so that their cold brine ends are inside the insulated room and the steam ends outside, giving easy access to all parts for operation or overhauling without having to disturb any insulation. This feature will be appreciated by those operating engineers who have had to work many hours removing and replacing wet insulation around the cold ends of brine pumps in order to effect some simple repair.

There are two water pumps placed in the lower main engine room, starboard side, one of which is a spare. These pumps, of course, are cross connected and they discharge their water through CO_2 condensers in which its temperature is raised about 3 degrees F.; then through the steam condenser, where it is further raised in temperature about 30 degrees F. This arrangement will appeal to engineers as it enables one pump to perform the work usually requiring two. The rise in temperature of the water in condensing the CO_2 gas is so small that it is immaterial for purposes of steam condensation. At sea the exhaust steam from the refrigerating plant is diverted to the main condenser and the auxiliary air and feed pumps shut down. The circulating water from CO_2 condensers is then by-passed overboard direct by a simple arrangement of valves provided for the purpose. Provision is made for varying the amounts of circulating water passed through the CO_2 condensers and the auxiliary steam condenser respectively.

The auxiliary feed pump for the refrigerating machinery draws the condensed steam from the auxiliary air pump hot well and discharges to the boilers direct through the main and auxiliary ranges or through the feed water heater.

A noticeable point is the careful design embodied in this plant by the contractors to effect maximum economy in operation. The coal required per day to operate the plant averages about three tons for a voyage with a full cargo of frozen meat.

There are two brine return tanks into which the individual returns from the brine circulation systems throughout the vessel are discharged through open connections and each is fitted with a thermometer registering the temperature of the brine coming back from its own particular pipe system.

The delivery and return valves from any one system of piping are placed immediately together, the delivery being above the return; and in addition each one is numbered and named to correspond with the piping plans of the ship, framed copies of which are placed in the engine room to guide the engineers in the operation of the plant. Fig. 4 shows this arrangement with the brine system in operation. Suitable arrangements are provided for heating the brine when desired to thaw out the coils in any meat chamber. This can be done without affecting the other chambers.

Fig. 9 shows the evaporator coils, all of which were tested to 3,000 pounds hydraulic pressure and afterwards to 1,500 pounds air pressure under water. Fig. 10 shows a set of these coils nested together and mounted on the bottom carrying-plate of one of the evaporator tanks, the ends protruding through stuffing boxes. It will be observed that this arrangement allows any coil to be removed without disturbing the remaining coils.

Fig. 11 shows five of the condenser and evaporator tank shells, one of which is on the hydraulic test block. All were tested to twice their working pressure.

Fig. 8 shows one of the cross compound duplex CO_2 50-ton machines, the CO_2 compressors being placed tandem to the steam cylinders. It will be noticed that the machine is so arranged that either side can be operated independently of the other side in case of an accident to one side. In such a case the operating steam side would be single expansion, but in ordinary operation the machine operates cross compound. The high pressure and low pressure steam receiver gages are placed immediately above the steam cylinders and are visible from the operating platform between the two sides of the machine. The machine takes steam from an auxiliary steam line at 150 pounds pressure (saturated) through a reducing valve and exhausts into the auxiliary or main condensers as desired. The machine normally operates at 80 revolutions per minute, but can be driven considerably faster for overload conditions; in fact, these machines were purposely operated at 140 revolutions per minute for 24 hours continuously as an overload trial and ran quite smoothly the whole time.

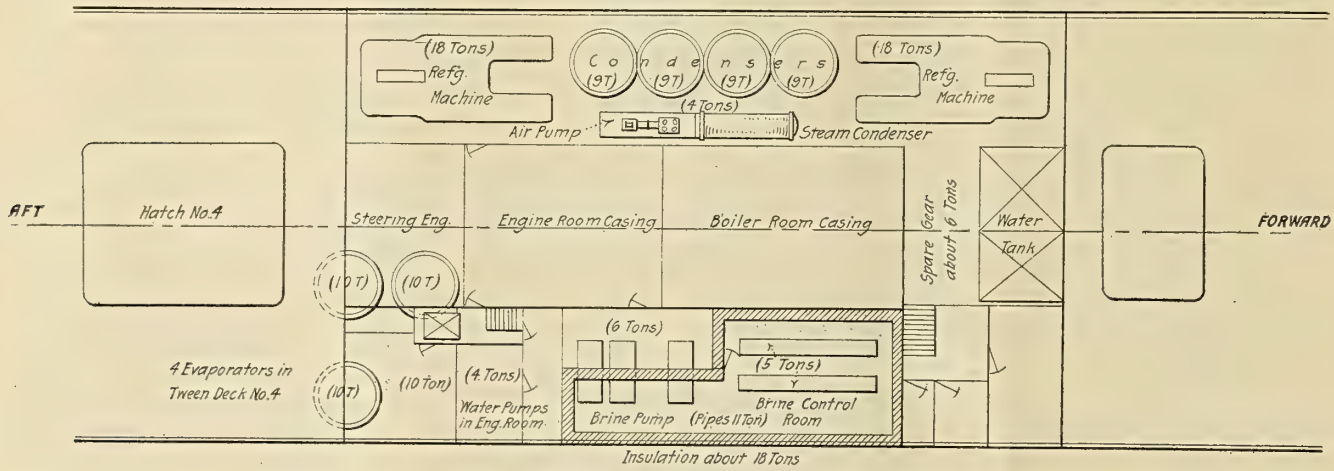


Fig. 7.—Trim Plan of Refrigerating Machinery Space

Co_2 Compressors

The carbonic acid compressors are each machined out of a nickel steel billet, all gas passages, cylinder bore and valve ports being machined to finish dimensions. The bore is ground and polished. The suction shut-off valve is formed integral with the compressor block, and the delivery shut-off valve is a steel block bolted to the side of the compressor (Fig. 8). Each valve has an outside threaded spindle of nickel steel working in a brass-bushed cast steel yoke. Immediately adjoining the delivery gas valve will be noticed the oil accumulator and oil pump reservoir, the former machined out of a nickel steel block and the latter a cast iron oil reservoir containing a hand-operated steel pump for keeping the accumulator fully charged. The oil reservoir and pump are fitted with a suitable brass wire gage strainer of very fine mesh. All the valve nuts and cylinder head nuts are of forged steel, case-hardened after machining. There are two suction and two discharge steel valves for each compressor, all working vertically and in steel cages fitted with separate steel

ONE OF THE CROSS COMPOUND DUPLEX CO_2 FIFTY-TON COMPRESSORS

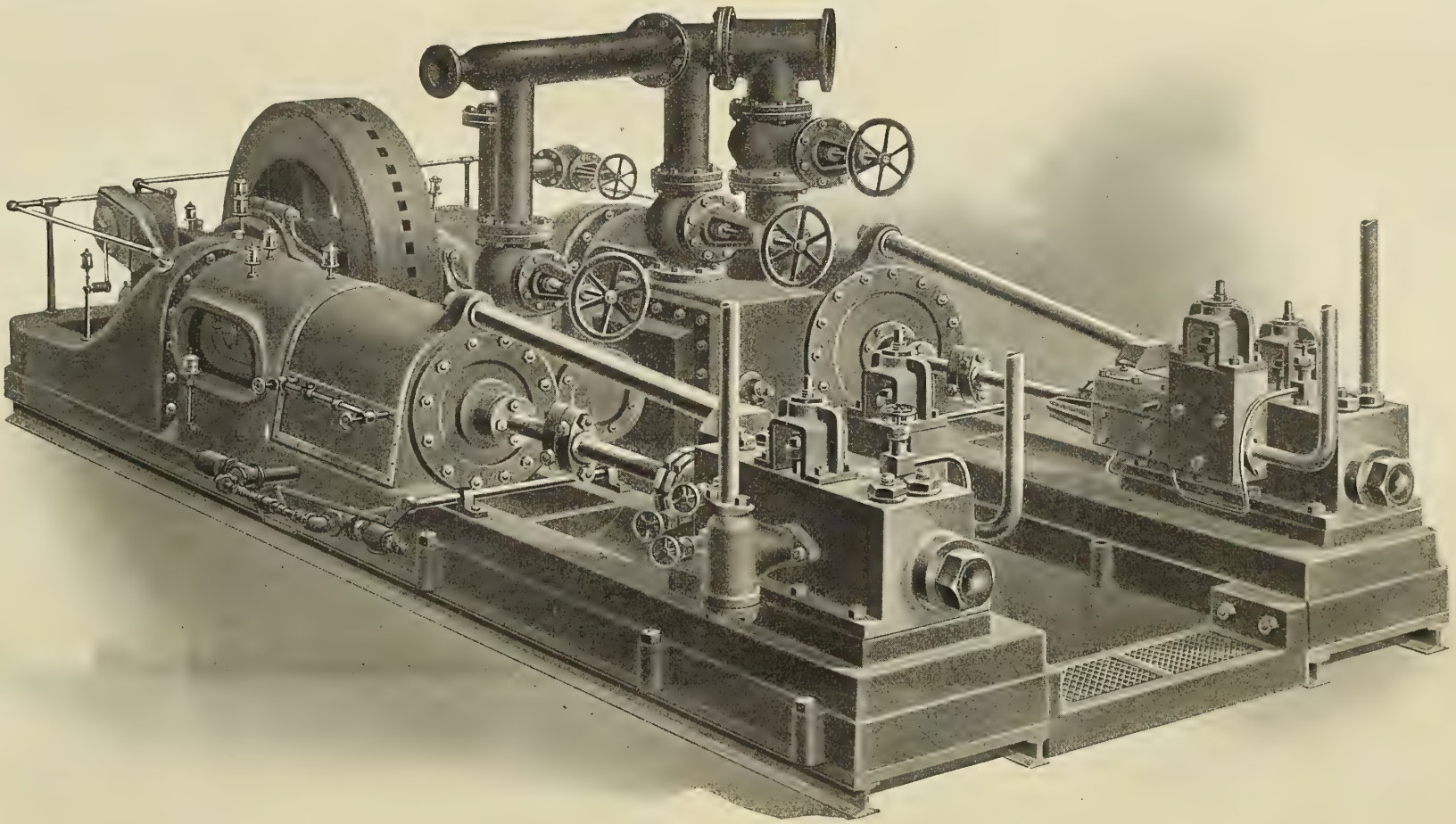


Fig. 8.—CO_2 Compressor

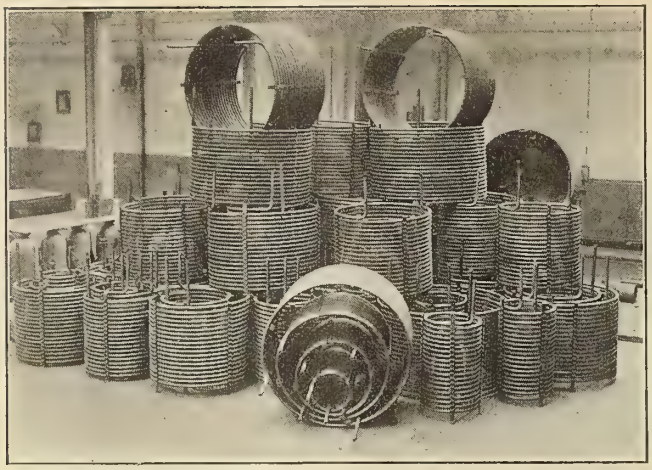


Fig. 9.—Evaporator Coils



Fig. 11.—Condenser and Evaporator Tank Shells

seats. All valves, seats, and springs for both suction and discharge valves are interchangeable, thus reducing the necessary spare gear.

All the CO_2 valves and headers throughout the system are machined from solid steel with malleable iron gland nuts and extra deep packing glands.

The compressor pistons are packed with leathers, the pistons and their rods being machined in one out of nickel steel forgings. The piston rod glands are packed with leathers separated by a bronze lantern gland. The space between the leathers is utilized as an oil reservoir and is maintained automatically at a pressure in excess of the condenser gas pressure by means of the oil accumulator. This system effectively prevents loss of gas from the glands and allows a slight leakage of oil from the glands into the compressor, so as effectively to lubricate the pistons and valves.

Oil passing through the compressor is separated from the gas by suitable steel separators placed between the compressors and condensers. The oil is drained from these separators and after being filtered is again used in the oil accumulator, thus minimizing the amount of oil used. An oil filter is mounted in the engine room for this purpose. The gage board and regulating valves for two CO_2 machines are shown in Fig. 12.

Brine Piping

The brine piping in the cargo spaces (Fig. 13) is arranged on the ceilings, bulkheads and sides and is formed of 1¼-inch wrought iron pipe electrically welded into continuous coils, which are attached to the ceilings by hanger bolts from the ship's beams through the insulation, carrying angle iron supports below the coils. The pipes on the sides and bulkheads are similarly arranged, but are supported by split hardwood grounds securely attached to the insulation grounds by means of lag screws. According to the estimates of the contractors the vessel contains over 22 miles of brine piping, from which an idea may be gained of the magnitude of the work.

To prevent the cargo from coming in contact with the cold pipes, the brine cooling coils on the sides and bulkheads are covered with wooden gratings attached to the pipe supports by lag screws, easily portable and arranged to allow an unrestricted air circulation about the cooling pipes. Figs. 13 and 14 show the arrangements of these cooling pipes and gratings in the No. 2 hold and 'tween deck cargo spaces, respectively, all other cargo spaces being similarly arranged. Fig. 13 also shows the arrangement of the cooling coils in the hatchways, as they appear when viewed from the underside, with the small entrance plug hatch in the way of the ladder removed. It will be noted that the hatch is divided into three sections by thwartship strongbacks carrying the insulated and ordinary cargo hatches, each section having a separate portable cooling coil carried from the hatch framing below the insulated hatch. Each coil has a special hatch by-pass valve attachment so arranged that the brine can be circulated through the remaining coil

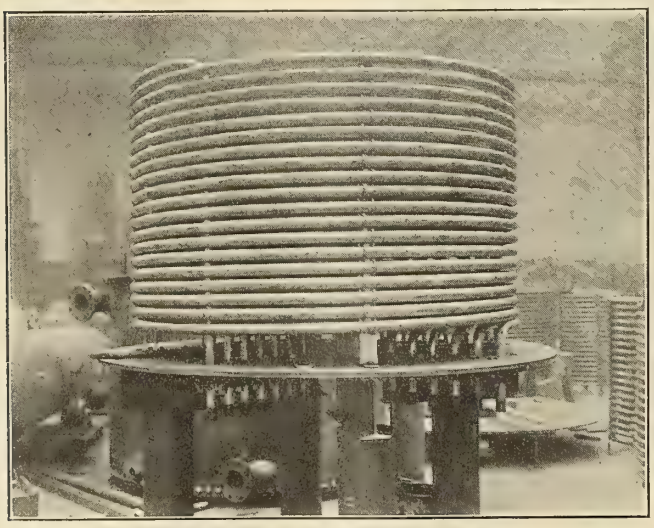


Fig. 10.—Evaporator Coil Assembled

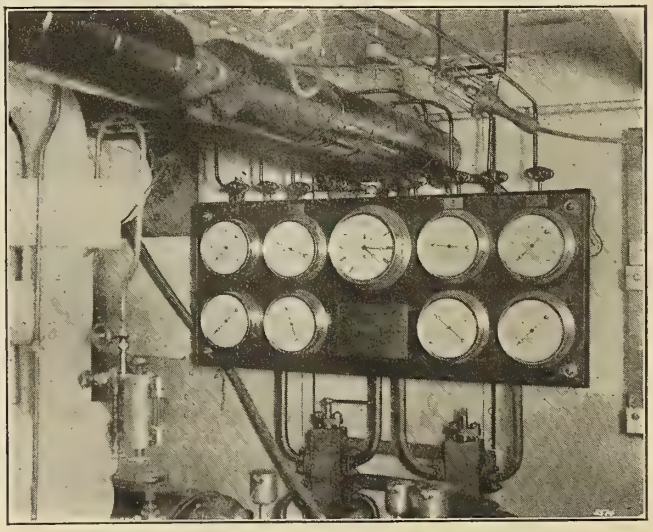


Fig. 12.—Gage Board and Regulating Valves

ARRANGEMENT OF BRINE COILS IN CARGO SPACES

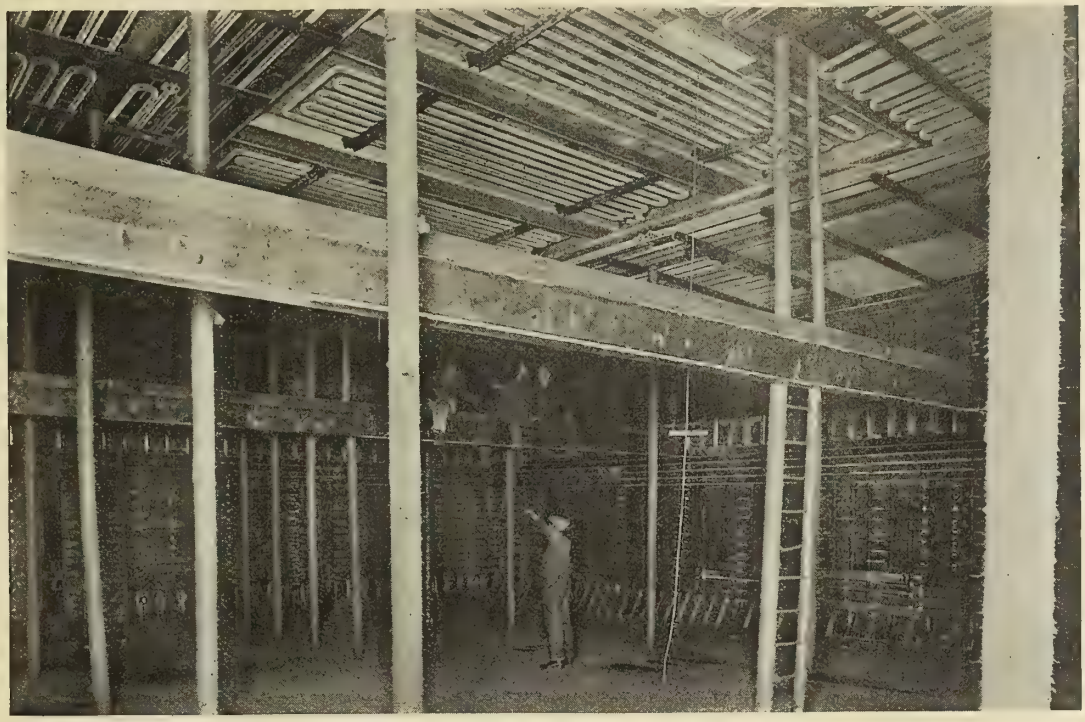


Fig. 13.—Brine Pipes in No. 2 Hold

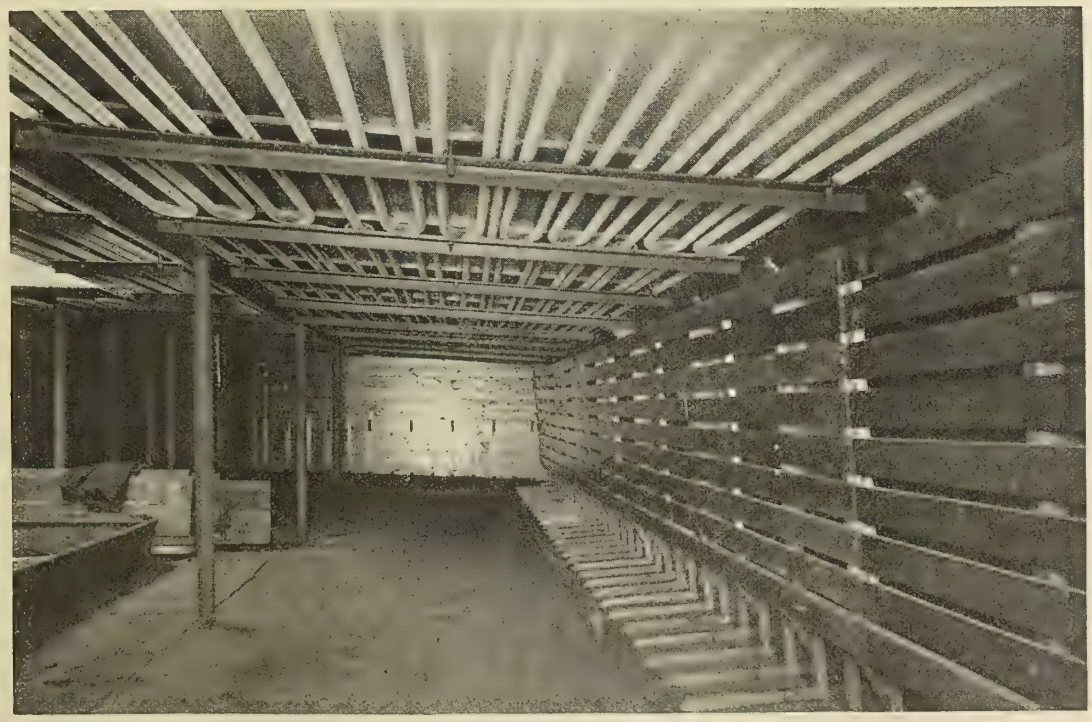


Fig. 14.—Brine Pipes and Gratings in 'Tween Decks Cargo Space

ARRANGEMENT OF BRINE COILS IN HATCHWAYS

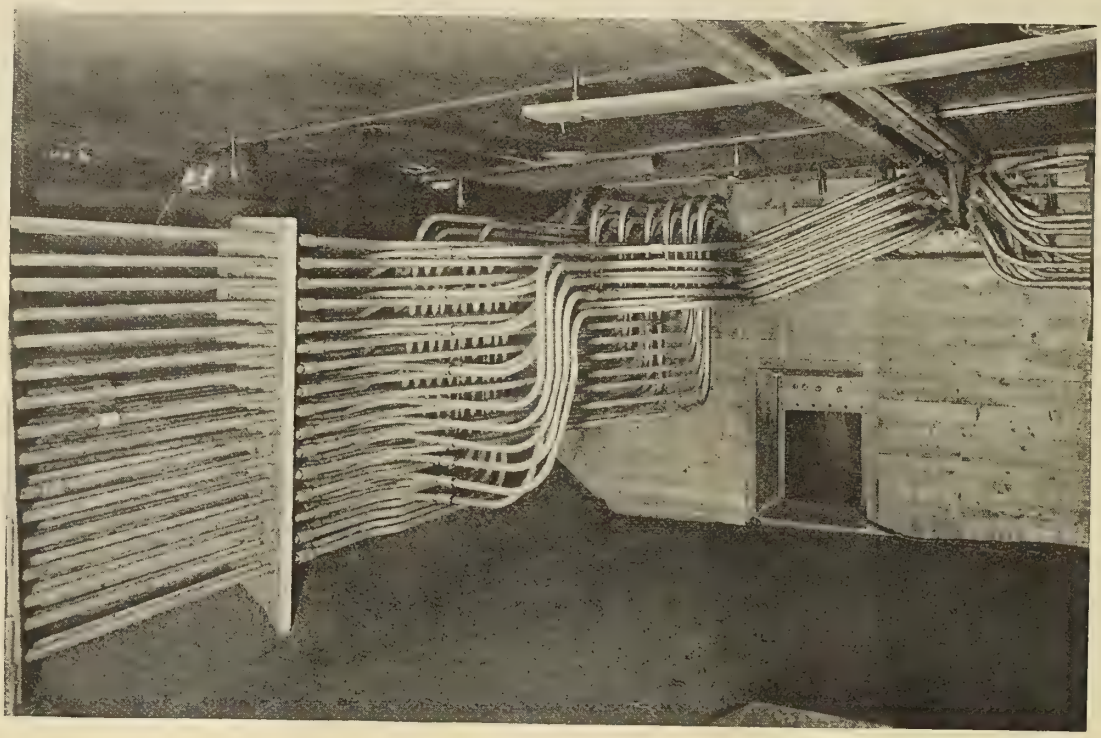


Fig. 15.—Delivery and Return Brine Mains

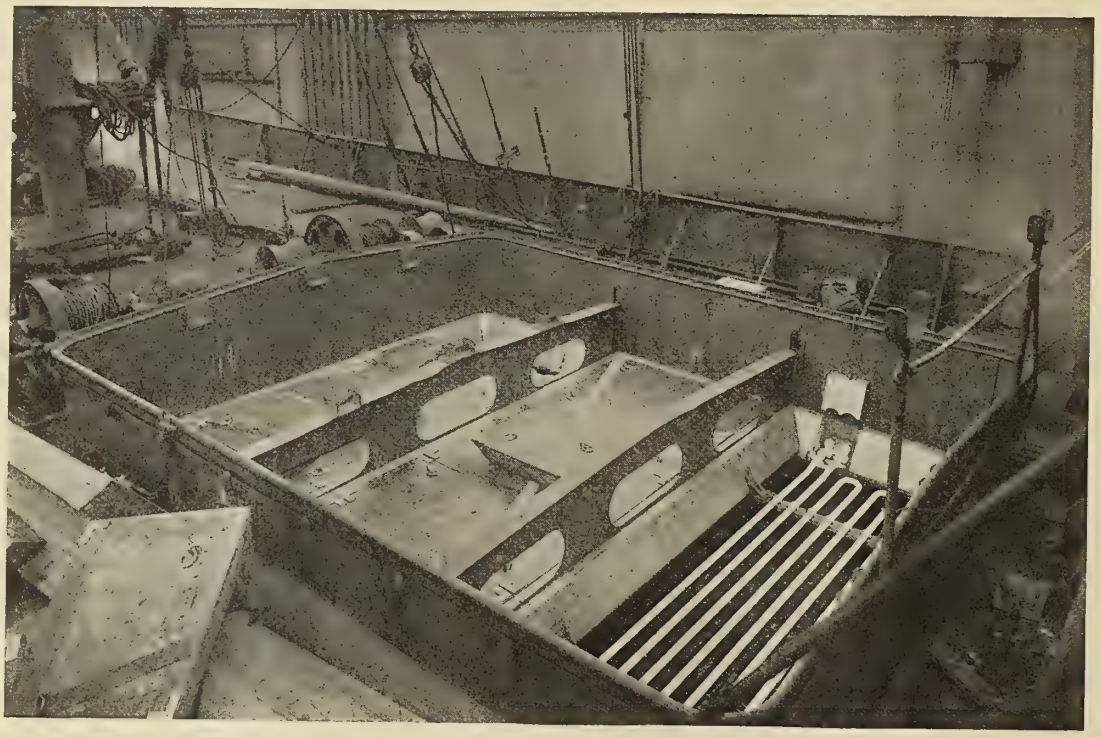


Fig. 16.—Insulated Hatch

MEAT TEMPERATURE LOG

19

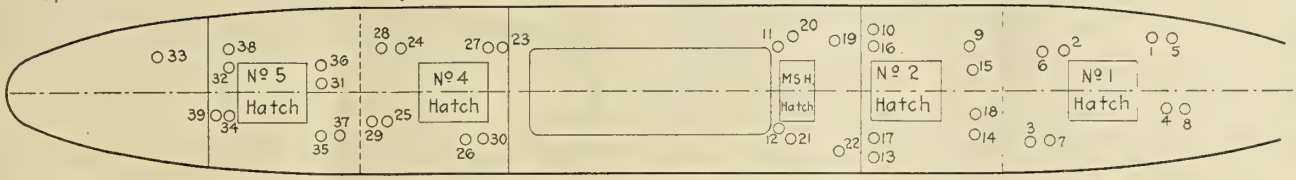


DIAGRAM OF LOCATION OF THERMOMETERS

DATE	TIME	No 1-T.D.				No 1-HOLD				No 2 - T. D.				No 2-HOLD				M.S.H.				No 4. T.D.				No 4-HOLD				No 5-T.D.				No 5-HOLD				REMARKS
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	
May 5 1916	6 A.M.	10	11	9	10	13	14	10	14	12	12	13	11	14	12	12	12	13	15	12	13	13	12	11	12	12	12	12	11	12	10	13	14	12	13	10	14	12	11	13	Left New York March 4th 6.30 P.M.
	6 P.M.	11	11	9	10	13	14	10	14	13	12	14	12	14	12	13	13	14	14	12	13	13	11	12	12	12	12	12	11	10	10	13	14	12	13	11	14	12	11	13	
6	6 A.M.	10	11	10	9	12	14	10	13	12	10	14	12	13	12	14	13	14	13	12	13	12	10	11	13	12	11	11	11	11	10	13	13	12	13	11	14	12	11	13	One Co_2 Machine only in operation
	6 P.M.	12	11	12	11	13	13	10	13	12	11	13	12	13	11	13	13	13	13	13	13	12	11	11	12	13	10	11	11	11	10	13	12	12	13	12	14	12	11	12	
7	6 A.M.	12	12	11	11	13	13	9	12	12	11	13	11	13	11	13	12	13	12	12	12	11	11	10	12	13	10	11	10	10	9	12	11	11	12	11	14	11	10	12	One Brine Pump in operation
	6 P.M.	12	11	11	11	12	12	9	12	12	11	12	11	13	11	12	12	13	12	12	12	11	11	10	13	12	10	11	10	10	9	12	11	11	12	11	13	11	10	12	
8	6 A.M.	12	11	11	12	12	12	9	11	12	11	12	11	12	10	11	12	12	12	11	12	11	11	10	12	12	10	11	10	10	9	12	12	11	12	11	13	11	10	12	
	6 P.M.	11	11	11	11	11	12	9	11	11	11	12	11	12	10	11	11	12	12	11	11	11	12	10	12	12	10	11	9	10	9	12	11	11	11	10	13	11	10	11	
9	6 A.M.	11	11	10	11	11	11	10	10	11	11	11	10	12	10	10	11	12	11	11	11	10	12	10	11	11	10	10	9	10	8	12	11	10	11	10	12	11	10	11	
	6 P.M.	11	11	10	10	10	11	10	10	11	10	11	10	11	10	10	11	11	11	11	11	10	11	10	11	11	10	10	10	10	9	12	10	10	10	10	12	11	10	11	
10	6 A.M.	11	11	10	10	10	11	10	10	11	10	11	10	11	10	10	10	11	11	10	11	10	11	10	11	11	10	10	10	10	9	11	10	10	10	10	11	10	10	11	
	6 P.M.	11	11	10	10	10	11	10	10	11	10	10	10	11	10	10	10	11	10	10	10	10	11	10	11	11	10	10	10	10	10	11	10	10	10	10	11	10	10	10	
11	6 A.M.	11	11	10	10	10	11	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	11	10	10	11	10	10	10	10	10	11	10	10	10	9	11	10	10	10	
	6 P.M.	11	11	10	10	10	11	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	11	10	10	11	10	10	10	10	10	10	9	10	10	10	11	9	10	10	

VOYAGE FROM New York TO Genoa, Italy

SIGNED ---------- CAPTAIN
---------- CHIEF OFFICER
---------- ENGINEER

Fig. 17.—Meat Temperature Log, Showing Week's Record of Operation of the Plant

ENGINEER'S LOG

DATE	TIME	FORWARD MACHINE								AFT MACHINE								VACUUM	WATER TEMP.			BRINE			REMARKS.
		STEAM		R.P.M.	CO_2 TEMP. CENT.					STEAM		R.P.M.	CO_2 TEMP. CENT.						SEA	CO_2 DISCH.	STEAM DISCH.	PRESS.	TEMP.		PUMP STROKE	
		H.P.	L.P.		H.P. $_1$	L.P. $_1$	H.P. $_2$	L.P. $_2$		H.P	L.P.		H.P. $_3$	L.P. $_3$	H.P. $_4$	L.P. $_4$							DEL.	RET.		
May 5 1916	12 P.M.	60	15	90	12	-24	12	-24											50	54		26	6	8	38	Plant exhausting to Main Condenser
	6 A.M.	60	15	90	12	-24	12	-24											50	54		26	6	8	38	Brine Pumps & water Pumps operating Compounded.
	12 M.	60	15	90	12	-24	12	-24											50	54		26	6	8	38	
	6 P.M.	60	15	90	12	-24	12	-24											50	54		26	6	8	38	
6	12 P.M.	60	15	90	12	-24	12	-24											50	54		30	6	8	39	1 Brine Pump working
	6 A.M.	60	15	90	12	-24	12	-24											50	54		30	6	8	39	1 Water Pump working
	12 M.	60	15	90	12	-24	12	-24											52	55		30	6	8	39	
	6 P.M.	60	15	90	13	-24	13	-24											52	55		30	6	8	39	aux. & Steam condenser, air Pump &
7	12 P.M.	60	15	90	13	-22	13	-22											52	55		30	7	8	40	feed pump shut down
	6 A.M.	60	15	90	13	-22	13	-22											52	55		28	7	8	37	
	12 M.	60	15	90	13	-22	13	-22											52	55		28	8	9	37	
	6 P.M.	60	15	90	13	-22	13	-22											52	55		28	8	9	38	
8	12 P.M.	60	15	90	13	-22	13	-22											52	55		28	8	9	38	
	6 A.M.	60	15	90	13	-22	13	-22											52	55		28	8	9	38	
	12 M.	60	15	90	14	-23	14	-23											52	55	By-pass over board open	30	7	9	39	
	6 P.M.	60	15	90	18	-23	18	-23											56	60		28	7	9	38	
9	12 P.M.	60	15	90	18	-24	18	-24											58	62		28	6	8	38	
	6 A.M.	60	15	90	18	-24	18	-24											61	65		28	5	7	38	
	12 M.	60	15	90	18	-26	18	-26											61	65		28	5	7	38	
	6 P.M.	60	15	90	18	-26	18	-26											61	65		28	4	6	38	
10	12 P.M.	60	15	90	18	-26	18	-26											61	65		28	3	5	38	Added 100 lbs. Co_2 to increase charge
	6 A.M.	60	15	90	18	-26	18	-26											61	65		28	2	4	38	in System.
	12 M.	60	15	90	18	-26	18	-26											61	65		28	2	4	38	
	6 P.M.	60	15	90	18	-26	18	-26											61	65		28	2	4	38	
11	12 P.M.	60	15	90	18	-26	18	-26											61	65		28	2	4	38	
	6 A.M.	60	15	90	18	-26	18	-26											61	65		28	2	4	38	
	12 M.	60	15	90	18	-26	18	-26											61	65		28	2	4	38	
	6 P.M.	60	15	90	18	-26	18	-26											61	65		28	2	4	38	

VOYAGE FROM New York TO Genoa - Italy SIGNED ---------- ENGINEER

Fig. 18.—Week's Record of One of the Carbonic Acid Machines

sections when one or more sections are removed for working cargo.

Fig. 15 shows the delivery and return brine mains.

Fig. 16 shows a top view of No. 3 hatch further indicating this arrangement. It also shows the method used in constructing these hatchways with their protecting iron work. The insulated hatches of the forward section have been removed and the hatch coil is ready to be shut off and disconnected for removal without loss of brine or interruption of the brine circulation system.

Meat Stowage

Fig. 1 is interesting in illustrating how frozen beef cargoes are loaded into the refrigerated compartments. The meat, it will be noted, is in quarters and is protected by cloth coverings sewn around them. The meat in this condition is carried at a temperature of about 15 degrees F.

Fig. 2 shows the method adopted in carrying chilled meat and illustrates very clearly, by comparison, the different styles of construction required to meet these conditions. The chilled meat is suspended from overhead meat rails arranged between the brine pipes and is covered with cloth similar to the frozen meat. This method of carrying chilled beef is due to the necessity for an unrestricted air circulation about the meat. The temperatures are maintained at about 28 degrees F.

Insulation

The insulating material on this vessel consists of regranulated cork, sheet cork and mineral wool, each being used as circumstances and position seemed most suitable. The ship's side, under deck, tank top, margin plates and stringer insulation are shown on the midship section (Fig. 19). The ship's side insulation consists of 3-inch by 3-inch grounds bolted to the face of the frames and covered by ⅞-inch tongued and grooved boards. The 9-inch space between the boards and the shell plating is tightly packed with regranulated cork. Over the ⅞-inch boarding is placed 1½-inch sheet cork with nailing strips, and the whole is covered by waterproof paper and a layer of 1⅛-inch tongued and grooved boards. This makes an overall insulation thickness of approximately 12⅜ inches.

The insulation on the underside of the decks consists of 6-inch by 2-inch grounds bolted to alternate frames by ⅞-inch bolts and covered by ⅞-inch tongue and grooved boards. The space between the deck plating and ⅞-inch boarding is packed with regranulated cork. Below the ⅞-inch boarding is packed a layer of 1½-inch cork with nailing strips, and the whole is covered with waterproof paper and ⅞-inch tongued and grooved boarding.

The margin plates of decks and bulkheads are insulated by a heavy hard wood ribbon, fitted and bolted watertight to the top side of the margin plate at four feet from the shell, carrying 2-inch tongued and grooved boarding fastened to the ship's side insulation. The space between the 2-inch boarding and the deck is packed with sheet cork and grouted in with a plastic mixture of granulated cork and pitch.

The insulation in way of beam knees is left portable for easy renewal of insulation filling in case of settlement.

The bulkheads are insulated, as shown on the drawings. Those bordering on the bunkers and engine spaces are packed with mineral wool to minimize the danger of fire.

The insulated limber hatches extend the whole length of the bilges and are shown on the midship section. They have frames and combings worked from solid timbers. Each hatch section is about six feet long and is fitted with two lifting ring bolts. All steel work is galvanized.

Fig. 17 shows a week's record as a typical example of the operation of the plant and records the readings of the several thermometers placed in the meat chambers.

Fig. 18 shows the operation of one of the carbonic acid machines over the same period. The forward machine only was in operation at the time and, in fact, one machine only was used throughout the whole voyage, sometimes the forward machine and sometimes the aft one.

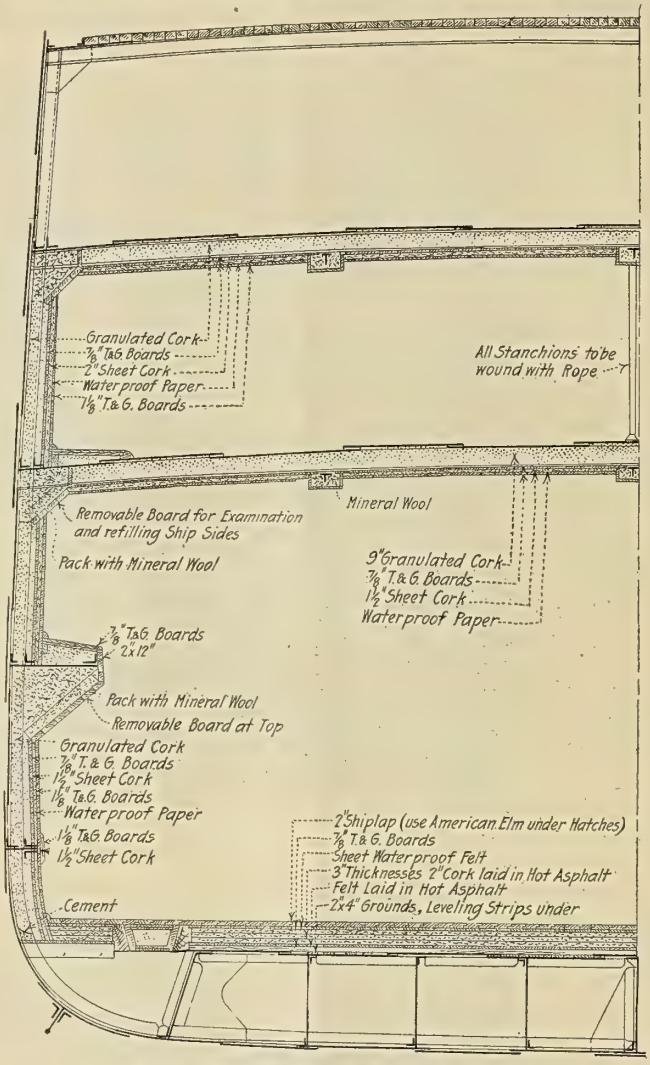


Fig. 19.—Midship Section, Showing Insulation

Fusible Plugs for Marine Boilers.—Amendments adopted by the Board of the United States Steamboat Inspectors on March 31, to its rules relating to fusible plugs, were as follows: Fusible plugs shall be "filled from end to end with tin not less than 99.5 per cent pure," in lieu of 99.7. Fusible plugs shall be renewed at each annual inspection, but in cases where the plugs were installed or renewed not more than six months prior to the annual inspection they may be allowed until the next following annual inspection or for a period not to exceed eighteen months. In such cases, however, the inspector shall satisfy himself at the annual inspection that the plugs are in such condition as to warrant their continued use until the next annual inspection, after which the plugs shall be renewed at each and every annual inspection. Manufacturers of fusible plugs shall furnish the Supervising Inspector-General a sample plug from each heat for examination and test, but where more than 250 plugs are poured from the same heat a sample plug shall be furnished for each 250 plugs, or fraction thereof. The samples furnished shall bear the same number from any one heat.

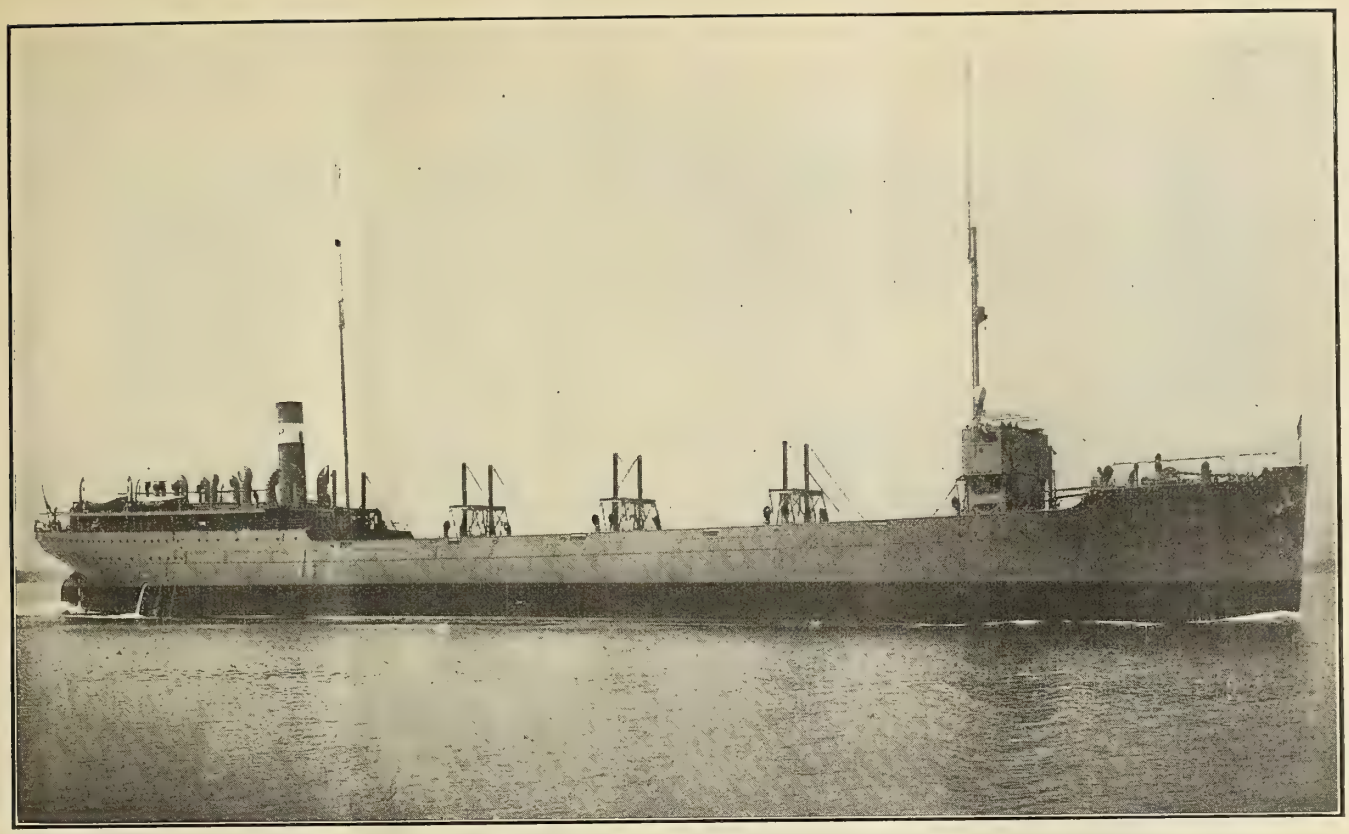


Fig. 1.—Panama Collier *Achilles*, Built by the Maryland Steel Company, Sparrows Point, Md.

The Panama Colliers Ulysses and Achilles

Twin Screw Vessels of 13,563 Tons Deadweight Capacity and 14 Knots Speed Built by the Maryland Steel Company

The Panama colliers *Ulysses* and *Achilles*, built last year by the Maryland Steel Company, Sparrow's Point, Md., differ from the colliers *Orion* and *Jason*, built by the same company for the United States Navy, in that they have no coal-handling appliances. They have, however, two masts for carrying radio gear and signals, and ten king posts for handling the hatch covers, which are of steel made in halves to hinge up.

In the *Ulysses* and *Achilles* there are four cargo holds separated by watertight bulkheads, and two oil holds forward, divided by a centerline bulkhead into four compartments.

Propulsion of the vessel is by twin screws driven by reciprocating engines of 7,200 combined indicated horsepower designed to give the ships a speed of 14 knots at a displacement of about 19,585 tons. The principal dimensions of the vessels are as follows:

Length overall	536 feet
Length between perpendiculars	514 feet
Beam, molded	65 feet
Depth, molded	39 feet 6 inches
Draft, loaded	28 feet 1 inch
Deadweight capacity on above draft	13,563 tons
Displacement	19,585 tons
Coefficient of fineness, block	0.724
Coefficient of fineness, midship section	0.984
Coefficient of fineness, load waterline	0.8
Designed indicated horsepower	7,200
Designed speed	14 knots

Accommodations are provided for 32 officers and a crew of 146 men. An American Engineering Company's steam anchor windlass is located on the forecastle, with a vertical, two-cylinder, 12-inch by 14-inch engine below on the main deck. The steering engine, also of the American Engineering Company's horizontal type, with two steam cylinders, 12 inches diameter by 12 inches stroke, is located on the main deck aft. Aft of the deck house on the poop deck is an American Engineering Company's capstan, operated by a horizontal steam engine with two cylinders 8 inches diameter by 8 inches stroke. There are eight deck winches of the horizontal, double-cylinder type, 8 inches by 8 inches, on the weather portion on the main deck for handling hatch covers, etc.

The propelling machinery is located in the stern and consists of two triple-expansion, vertical, inverted, reciprocating engines supplied with steam by three Scotch double-end boilers, 16 feet diameter by 22 feet 1 inch long, operating under Howden's system of forced draft at a working pressure of 200 pounds per square inch.

The main-engine cylinders are 27½ inches, 46 inches and 76 inches diameter by 48 inches stroke, and are especially designed for high economy. Piston valves are fitted to all cylinders, and all ports are straight, which keeps the clearance volume down to a minimum. The connecting rods are 9 feet 3 inches between centers and are fitted with cast steel boxes, top and bottom. The crosshead slippers are also of cast steel and work on hollow "bar" type guides fitted with water service.

The main bearings consist of bottom semi-circular boxes, fitted into square-bottomed saddle pieces. The caps are of cast steel. This arrangement permits the semi-

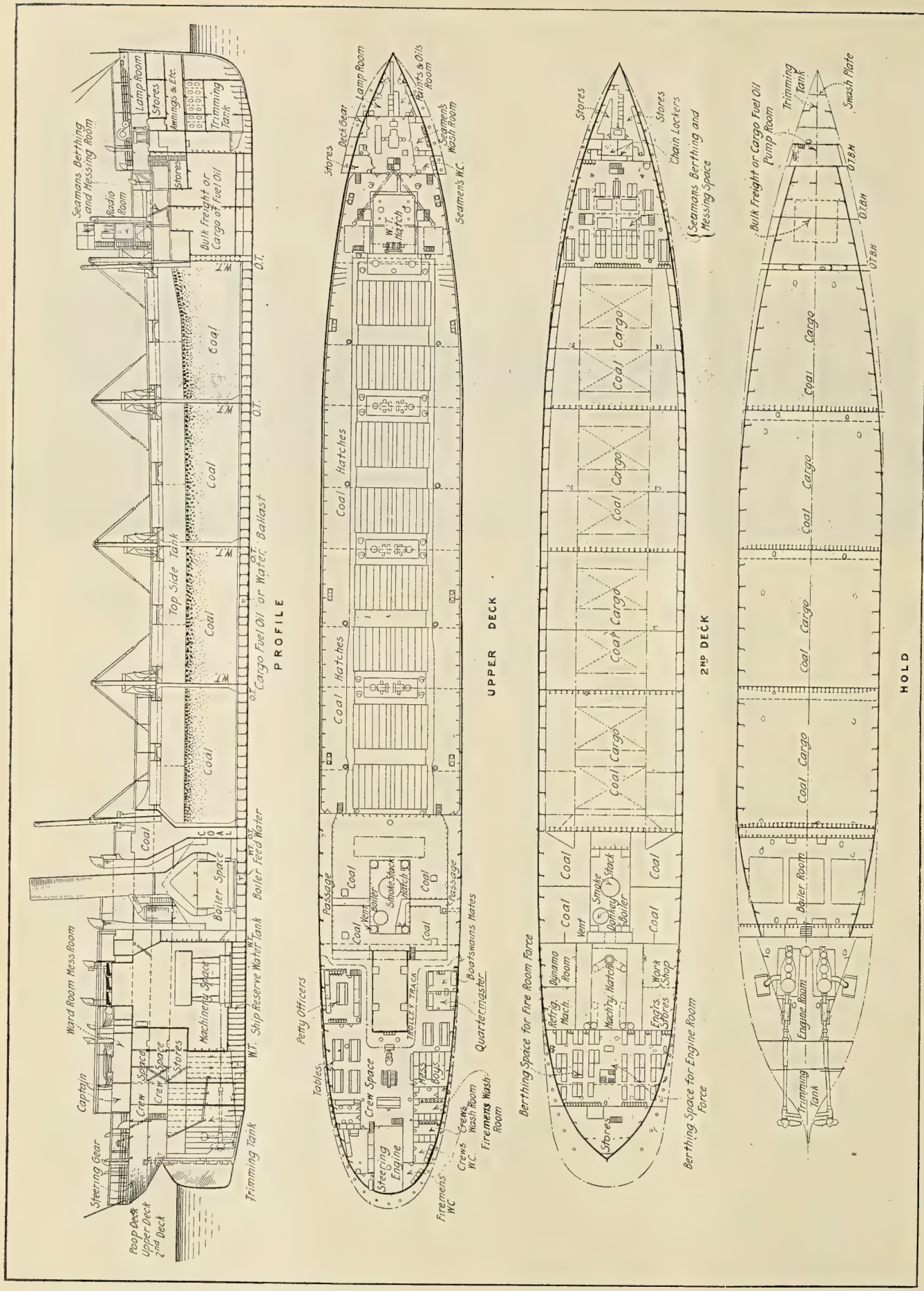


Fig. 2.—Profile and Deck Plans of Panama Colliers *Ulysses* and *Achilles*

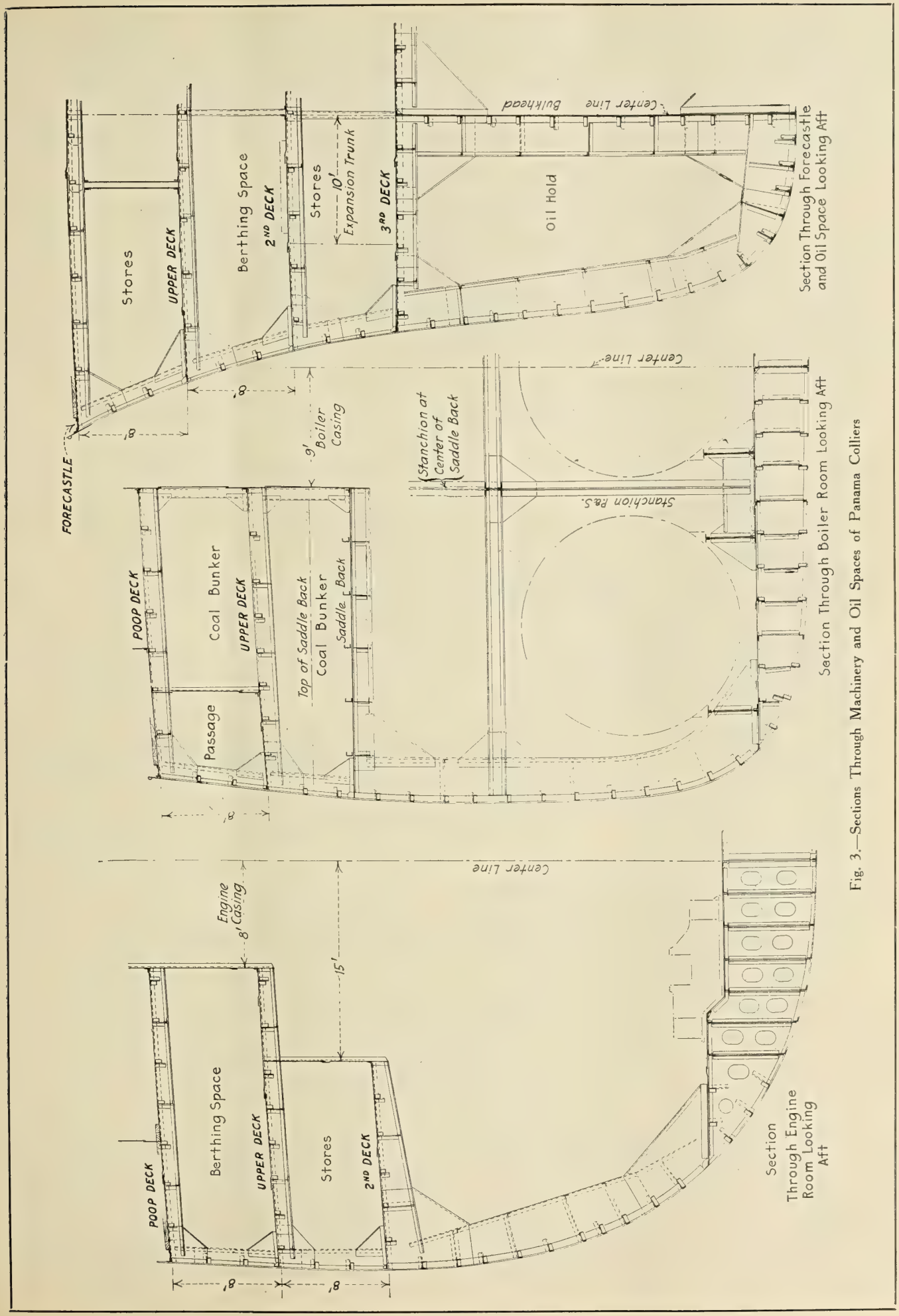


Fig. 3.—Sections Through Machinery and Oil Spaces of Panama Colliers

circular boxes being removed without lifting the crankshaft. The reversing gear is at the back of the engine, and consists of the usual type of steam ram, actuating a steel shaft, which is fitted with cast steel adjustable reverse arms.

The main air pumps are operated by levers from the intermediate pressure cylinder crossheads, and are of the Edwards type, 22 inches diameter by 18 inches stroke.

Steam is supplied, as previously mentioned, by three double-end Scotch boilers, each 16 feet diameter by 22 feet 1 inch long, built for 200 pounds per square inch working pressure to Lloyd's and the United States Steamboat Inspection rules. The total heating surface is 19,635 square feet, and the total grate surface 451 square feet. The boilers operate under the Howden system of hot forced draft, with coal fuel. Each boiler contains eight

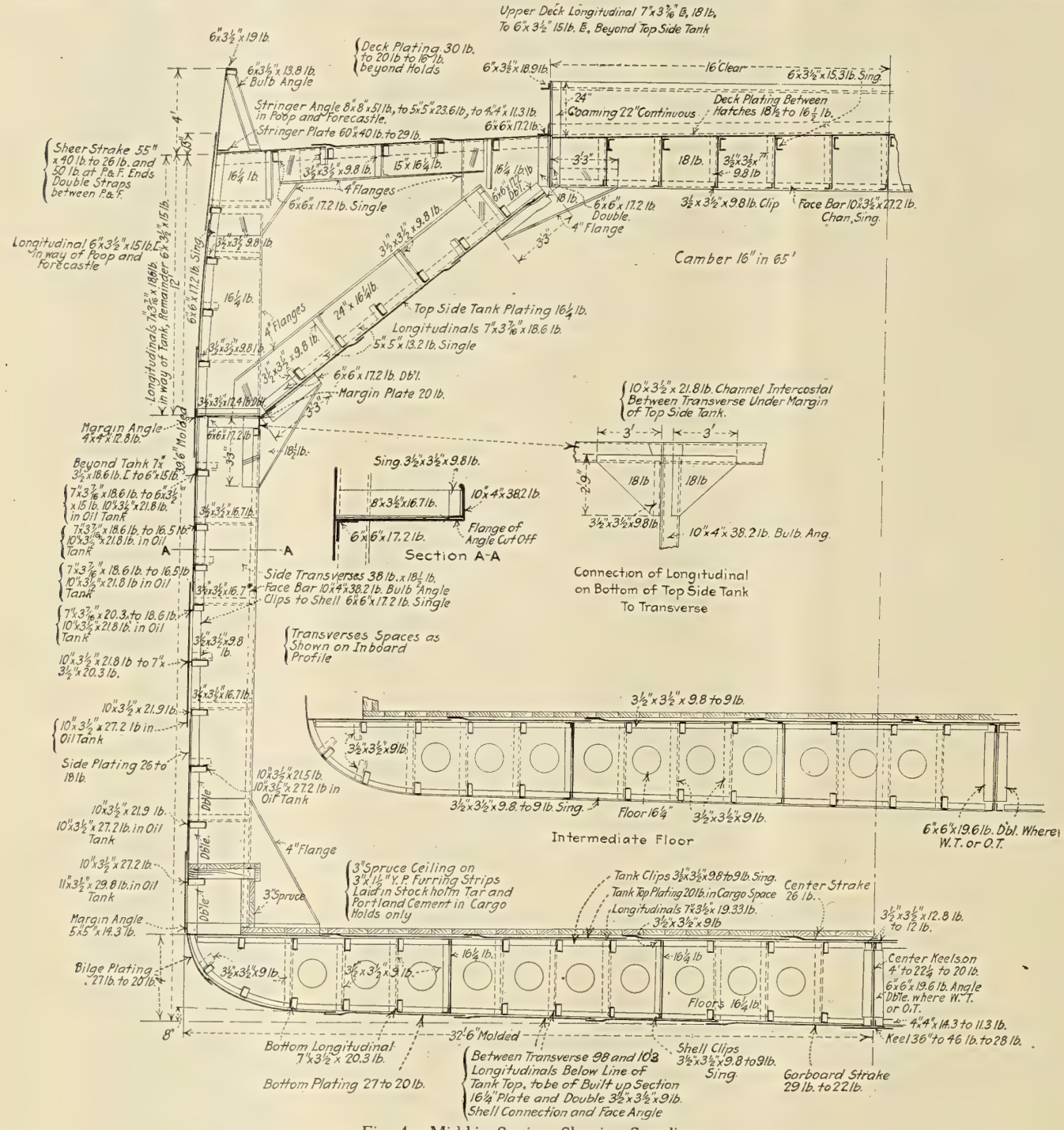


Fig. 4.—Midship Section, Showing Scantlings

There are two bilge pumps attached to the air-pump crosshead, each 5 inches diameter by 18 inches stroke.

The thrust blocks are of the horseshoe type, the collars running in a water-cooled oil bath.

The propellers are of the built-up type, each having three manganese bronze blades, mounted on a cast steel hub. The wheels are 17 feet diameter, with an adjustable pitch of from 16 feet to 18 feet, and have a developed area of 94.3 square feet.

41-inch inside diameter corrugated furnaces, each having its own combustion chamber. The tubes are 2½ inches diameter and fitted with spiral retarders. There are two multi-vane forced draft blowers, located over the wing boilers in the fireroom.

The following auxiliaries are installed and fitted up in keeping with the highest class of merchant practice:

Two main condensers, each having 5,300 square feet of cooling surface.

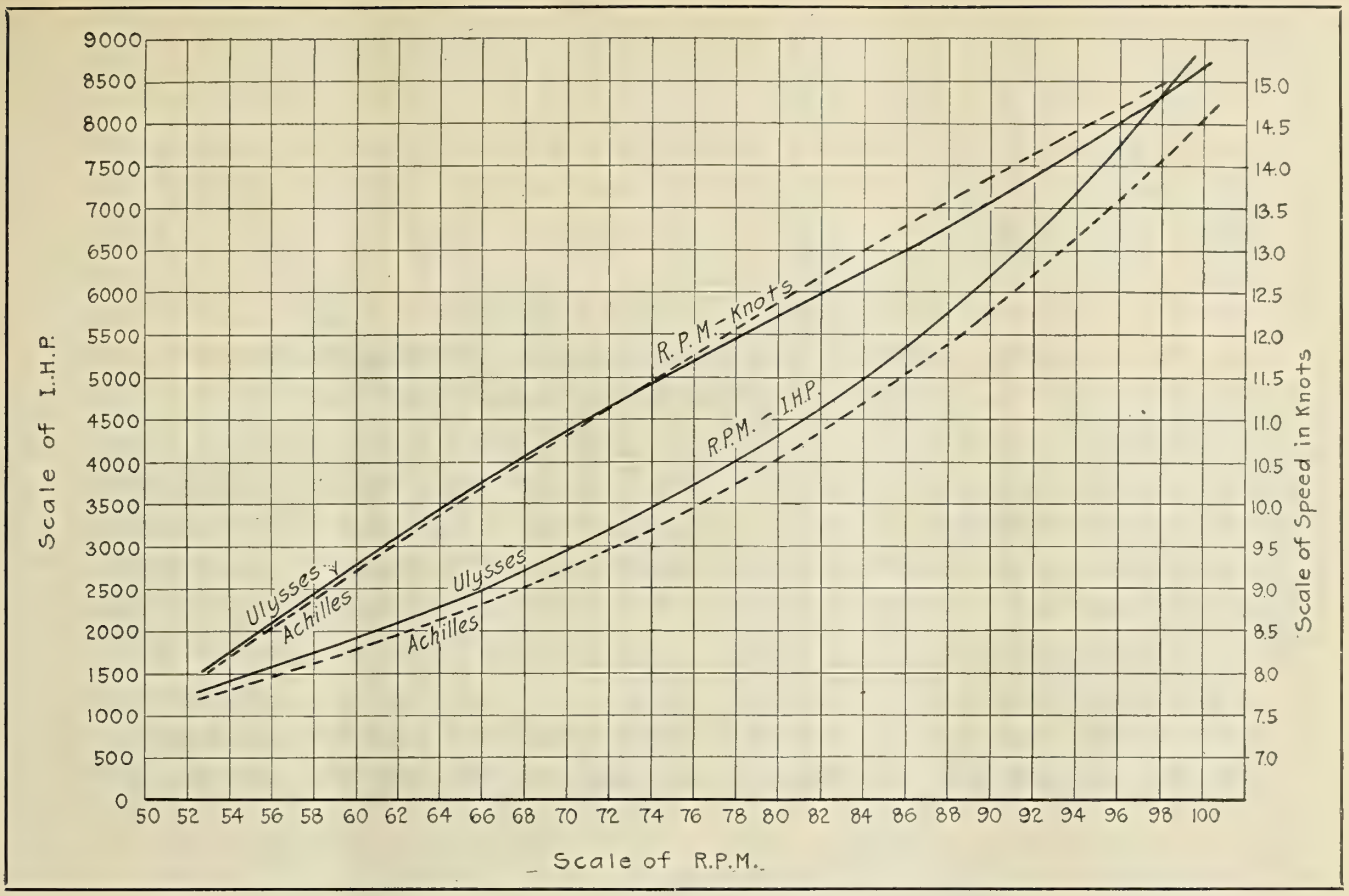


Fig. 5.—Speed-Power Curves from Official Trials of Panama Colliers

Two main centrifugal circulating pumps having 14-inch diameter nozzles and driven by vertical single-cylinder, 10-inch by 9-inch steam engines.

Two main and one auxiliary feed pumps of the vertical simplex type, having cylinders 14 inches and 9 inches diameter by 24 inches stroke.

One fire and bilge pump of the vertical, simplex type, having cylinders 12 inches and 14 inches diameter by 12 inches stroke.

One ballast pump of the vertical duplex type, having cylinders 12 inches and 14 inches diameter by 12 inches stroke.

One sanitary pump of the vertical simplex type, having cylinders 8 inches and 8 inches diameter by 12 inches stroke.

One ash ejector pump of the vertical duplex type, having cylinders 14 inches and 8½ inches diameter by 12 inches stroke.

One fresh-water pump of the vertical simplex type, having cylinders 4½ inches and 6 inches diameter by 6 inches stroke.

One auxiliary condenser having 925 square feet of cooling surface, with an independent vertical simplex air pump with cylinders 7½ inches and 14 inches diameter by 10 inches stroke, and an independent centrifugal circulating pump having 6-inch nozzles and driven by a 6-inch by 6-inch steam engine.

Two multi-coil evaporators, having a total capacity of 8,000 gallons per 24 hours and fitted with an independent vertical simplex 4½-inch by 6-inch by 6-inch feed pump.

Two multi-coil distillers having a total capacity of 4,000 gallons per 24 hours and fitted with an independent vertical simplex, 8-inch by 8-inch by 12-inch circulating pump.

One multi-coil feed-water heater and a cartridge grease extractor having 5-inch diameter connections.

One vertical donkey boiler, 7 feet diameter by 11 feet high, built for 200 pounds per square inch working pressure and fitted with a vertical simplex, 6-inch by 4-inch by 8-inch feed pump.

Two vertical duplex cargo oil pumps located in the pump room forward, having cylinders 14 inches and 12 inches diameter by 18 inches stroke.

One two-ton capacity refrigerating plant for the ship's stores, fitted with a 9-can ice-making set.

Two 25-kilowatt turbo-generating sets, located in the dynamo room.

All of the pumps enumerated above were supplied by the Warren Steam Pump Company, Warren, Mass. The evaporators, distillers and feed-water heaters were manufactured by the Griscom-Russell Company, New York. The refrigerating plant was furnished by the Brunswick Refrigerating Company, New Brunswick, N. J., and the electric generating sets were furnished by the B. F. Sturtevant Company, Hyde Park, Mass.

The keel of the *Ulysses* was laid on May 19, 1914; she was launched on December 12, 1914, and her trials were held on April 14 and 15, 1915. The keel of the *Achilles* was laid on May 21, 1914; she was launched on February 6, 1915, and her trials were held on June 8 and 9, 1915. The contract date for delivery of the vessels was August 9, 1915; the actual date of delivery of the *Ulysses* was April 17, 1915, and of the *Achilles,* June 10, 1915.

On her standardization trial over the Delaware Breakwater course the *Achilles* made an average speed of 15.23 knots for the high-speed runs, and an average of 14.281 knots for the 24-hour endurance run at sea. This speed could have been exceeded on the endurance run, but for reasons of economy it was kept down to this figure. The average of the *Ulysses* over the standardization course was 14.99 knots. The trials were carried out with the ves-

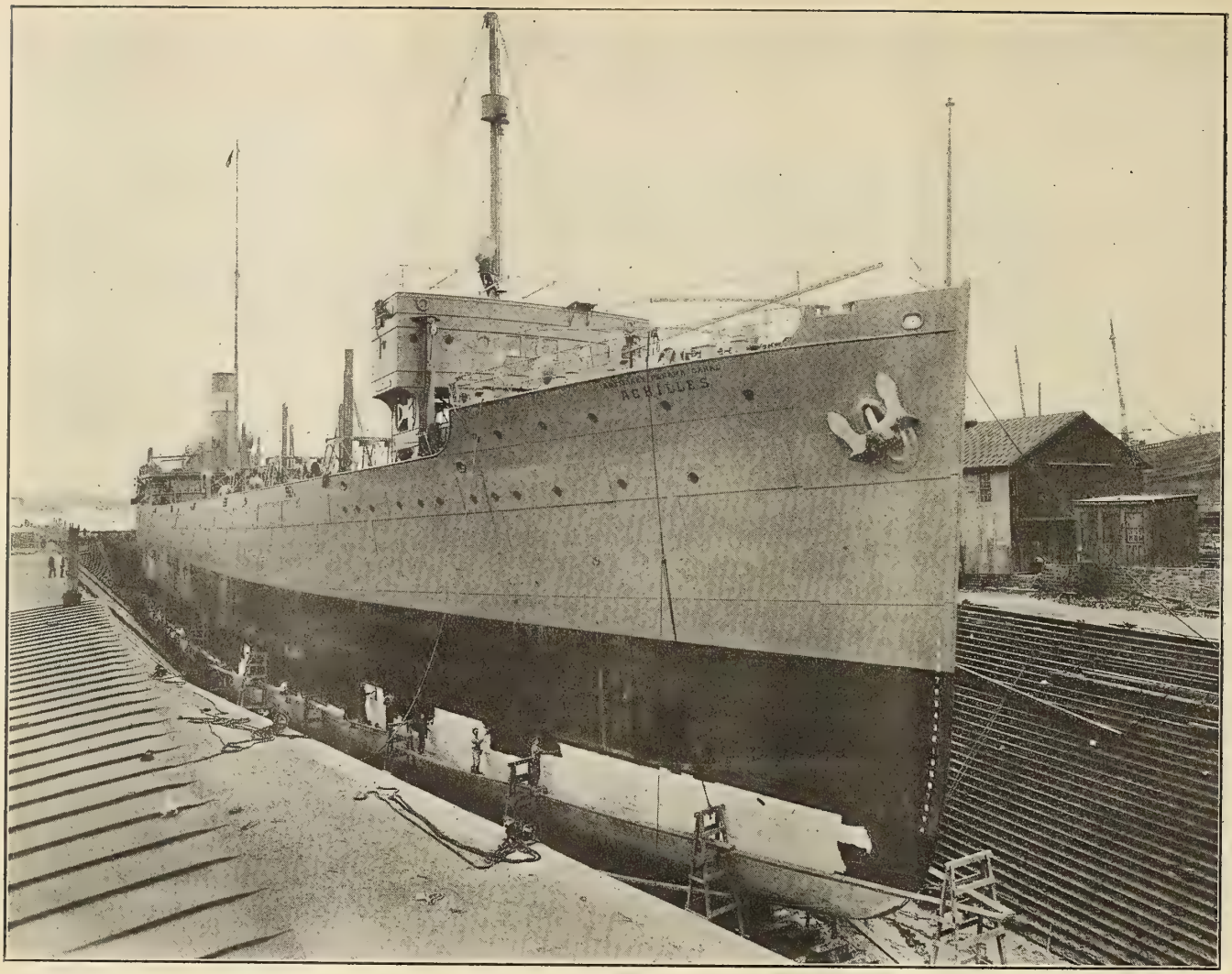


Fig. 6.—Panama Collier *Achilles* Being Cleaned and Painted in the Upper Dock of the Baltimore Dry Docks & Shipbuilding Company

sels loaded with 13,305 tons of deadweight on the load draft.

Each vessel was delivered to the Panama Canal authorities within twenty-four hours after the completion of the trials, and sailed on the first voyage within forty-eight hours of the finish of the trials, which establishes another world's record for the Maryland Steel Company, the builders of the vessel.

Regulations for Oil Burning Vessels

Amendments to the rules and regulations relating to the installation of fuel oil tanks on steamers and to applications for permission to use petroleum as fuel on ships have been adopted by the Board of Supervising Inspectors of the United States Steamboat Inspection Service. Greater discretion has been given to the respective inspectors of the districts in deciding how the tanks shall be installed on ocean steamers, and it is ordered that an application for permission to use petroleum as fuel must be made in duplicate to the supervising inspector of the district in which the vessel is at the time she is equipped for that purpose.

In revising the rules that govern oil burning ships the board struck out an entire section, including more than a page of specific instructions on the building of tanks to be used on ocean and coastwise vessels. A new provision extended to ocean shipping the more general provision that has heretofore applied to shipping on lakes, bays, sounds and rivers. It added for each of these classes of ships the provision that application must be made in the way specially prescribed for permission to use oil fuel. The new provision for ocean or inland steamers reads:

"The fuel oil tanks on all (ocean or inland) steamers, subject to the rules and regulations of the Steamboat Inspection Service, shall be constructed of material of such thickness and workmanship as, in the judgment of the inspector in whose district the installation is made, is safe.

"Application for permission to use petroleum as fuel must be made in duplicate to the supervising inspector of the district in which the vessel is at the time she is equipped to use oil as fuel. Application to use petroleum as fuel must be made on the blanks furnished for that purpose. Two blueprints or tracings showing the proposed installation of the tanks, pumps, piping, valves and burners must accompany the application."

MERCHANT SHIPPING.—After extended investigation the National Foreign Trade Council, in a statement submitted to Congress on May 17, pointed out that to increase the 14.3 percent of American foreign commerce carried by American ships in 1915, to 60 percent ten or fifteen years hence, would require from 6,000,000 to 10,000,000 gross tons of steamers, worth over one-half a billion dollars at the least.



Fig. 1.—Government Survey Steamer *General C. B. Sears*

Harbor Survey Boat General C. B. Sears

Government Vessel Built on the Great Lakes by Army Engineers for Harbor Improvement Service

A STEEL survey boat of 296 tons displacement, capable of a speed of 12 miles per hour, has recently been completed at Muskegon, Mich., for the Duluth (Minn.) United States Engineer District for service in improving the harbors on the Great Lakes. The contract for the construction of this boat was awarded to the Racine Trustcott Hull Lake Boat Company, Muskegon, Mich., but owing to the failure of this concern while the hull was still on the stocks, the plant of the contractor was taken over by the United States engineers and the boat was completed under the direction of the Engineers' office.

The boat is propelled by a single screw driven at 118 revolvutions per minute by a compound surface condensing engine built by the Spedden Shipbuilding Company, Baltimore, Md. The pumps were supplied by the M. F. Davidson Company, New York. A full surface condensing equipment was installed in order that the boat could be transferred for duty in salt water if required.

The principal dimensions of the hull are as follows:

Length over all	110 feet 7¼ inches
Length between perpendiculars	105 feet 7¼ inches
Beam, molded	22 feet
Depth, molded	12 feet
Draft, forward, approximate	8 feet 6 inches
Draft, aft, approximate	10 feet 6 inches
Displacement, approximate	296 long tons

As can be seen from the general plans, the vessel has an enclosed forecastle. This feature was found to be an advantage, as during a run in Lake Erie in the teeth of a gale solid water reached the level of the forecastle deck without wetting the forecastle and main decks. In this case the seas were short, about the length of the hull.

Spacious quarters for the officers and crew are conveniently located, as shown on the general arrangement plan. The life-saving equipment consists of a 16-foot metallic lifeboat and a life raft with a capacity for ten persons. The vessel is heated throughout by steam and lighted by electricity, a 5 kilowatt 110-volt turbo generator being installed in the engine room.

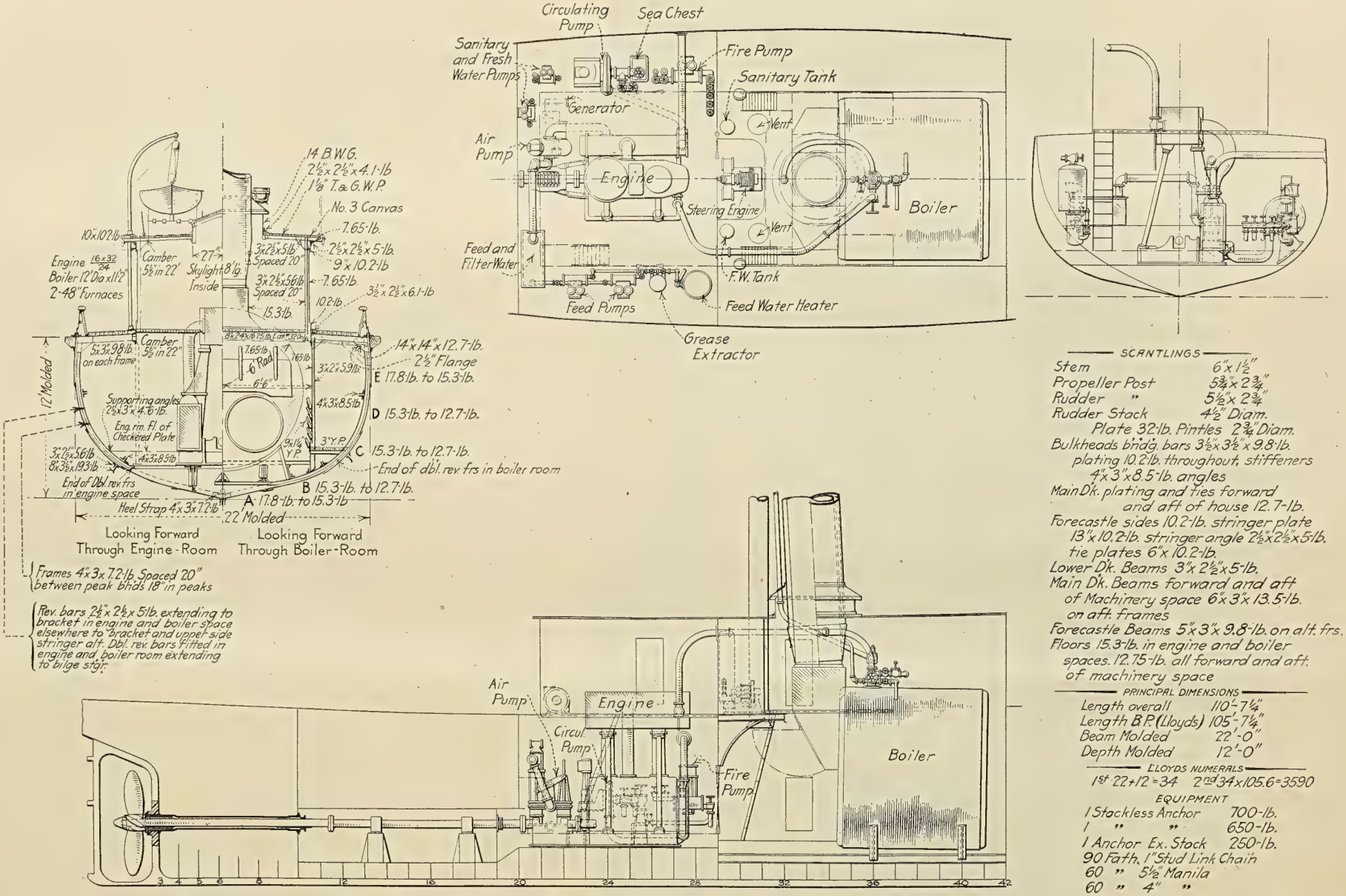
Propulsion is by a single screw driven by a vertical-inverted, direct-acting open frame surface condensing fore-and-aft compound engine designed to operate at a speed of 125 revolutions per minute with a working steam pressure at the boilers of 150 pounds per square inch. The cylinders of the engine are 16 inches and 32 inches diameter by 24 inches stroke.

The high-pressure valve is of the piston type, the low pressure valve a double ported slide valve. The valves are operated by double eccentric through Stevenson link motion. The low pressure steam chest is provided with a balanced cylinder cast on the cover with a bore of about 6 inches diameter.

The cylinders are supported at the back by two cast iron columns of box section and at the front by two steel turned columns tapering from 4 inches diameter at the head to 4½ inches diameter at the foot.

The reversing gear is direct acting, having a steam cylinder 6 inches diameter by 9 inches stroke directly connected to the reversed shaft by a lever with control gear to prevent slamming.

The crank shaft is of the solid forged type of steel 7½ inches diameter with main bearing surfaces 5¾ inches long. The crank pins are 7½ inches in diameter and 8½ inches long. The cranks are set at angles of 90 degrees to each other. The thrust shaft is of forged steel 7¼



SCANTLINGS

Stem	6"x1½"
Propeller Post	5¾"x2¾"
Rudder "	5½"x2¾"
Rudder Stock	4½" Diam.

Plate 32-lb. Pintles 2¾" Diam.
Bulkheads bhd'g. bars 3½"x3½"x9.8-lb. plating 10.2-lb. throughout, stiffeners 4"x3"x8.5-lb. angles
Main Dk. plating and ties forward and aft of house 12.7-lb.
Forecastle sides 10.2-lb. stringer plate 13"x10.2-lb. stringer angle 2½"x2½"x5-lb. tie plates 6"x10.2-lb.
Lower Dk. Beams 3"x2½"x5-lb.
Main Dk. Beams forward and aft of Machinery space 6"x3"x13.5-lb. on aft. frames
Forecastle Beams 5"x3"x9.8-lb. on alt. frs.
Floors 15.3-lb. in engine and boiler spaces. 12.75-lb. all forward and aft. of machinery space

PRINCIPAL DIMENSIONS

Length overall	110'-7¼"
Length B.P. (Lloyds)	105'-7¼"
Beam Molded	22'-0"
Depth Molded	12'-0"

LLOYDS NUMERALS

1st 22+12=34 2nd 34x105.6=3590

EQUIPMENT

1 Stockless Anchor	700-lb.
1 " "	650-lb.
1 Anchor Ex. Stock	250-lb.
90 Fath. 1" Stud Link Chain	
60 " 5½" Manila	
60 " 4" "	

Fig. 2.—General Machinery Arrangement, S. S. *General C. B. Sears*

inches diameter provided with six 1⅛-inch thrust collars forged on. The thrust bearing is of the usual horseshoe type. The tail shaft is in one piece 7¾ inches diameter.

The propeller is four-bladed of cast steel with a diameter of 8 feet and a pitch of 11 feet 9 inches.

The main condenser, which is located under the back columns of the engine, has a cooling surface of 650 square feet. The shell is of cast iron and the tubes of brass ¾-inch outside diameter of No. 18 B. W. G. tinned outside and inside. The air pump is of the vertical, simplex, twin beam, single acting type, having one 7-inch diameter, double acting, inverted steam cylinder and two 12-inch diameter single acting air cylinders, all having a common stroke of 12 inches. The circulating pump is of the centrifugal type with an 8-inch suction and a 6-inch discharge direct connected to a 4½-inch by 4-inch vertical engine. All of the pumps on this vessel were supplied by the M. T. Davidson Company, New York. They include the following, in addition to those already described:

One vertical duplex fire deck and bilge pump with 7½-inch steam cylinders, 3¼-inch water cylinders and 7-inch stroke.

Two vertical duplex boiler feed pumps of the pot valve type with 5½-inch steam cylinders, 3½-inch water cylinders and 6-inch stroke.

One vertical duplex fresh water pump with 3-inch steam cylinders, 3-inch water cylinders and 3-inch stroke.

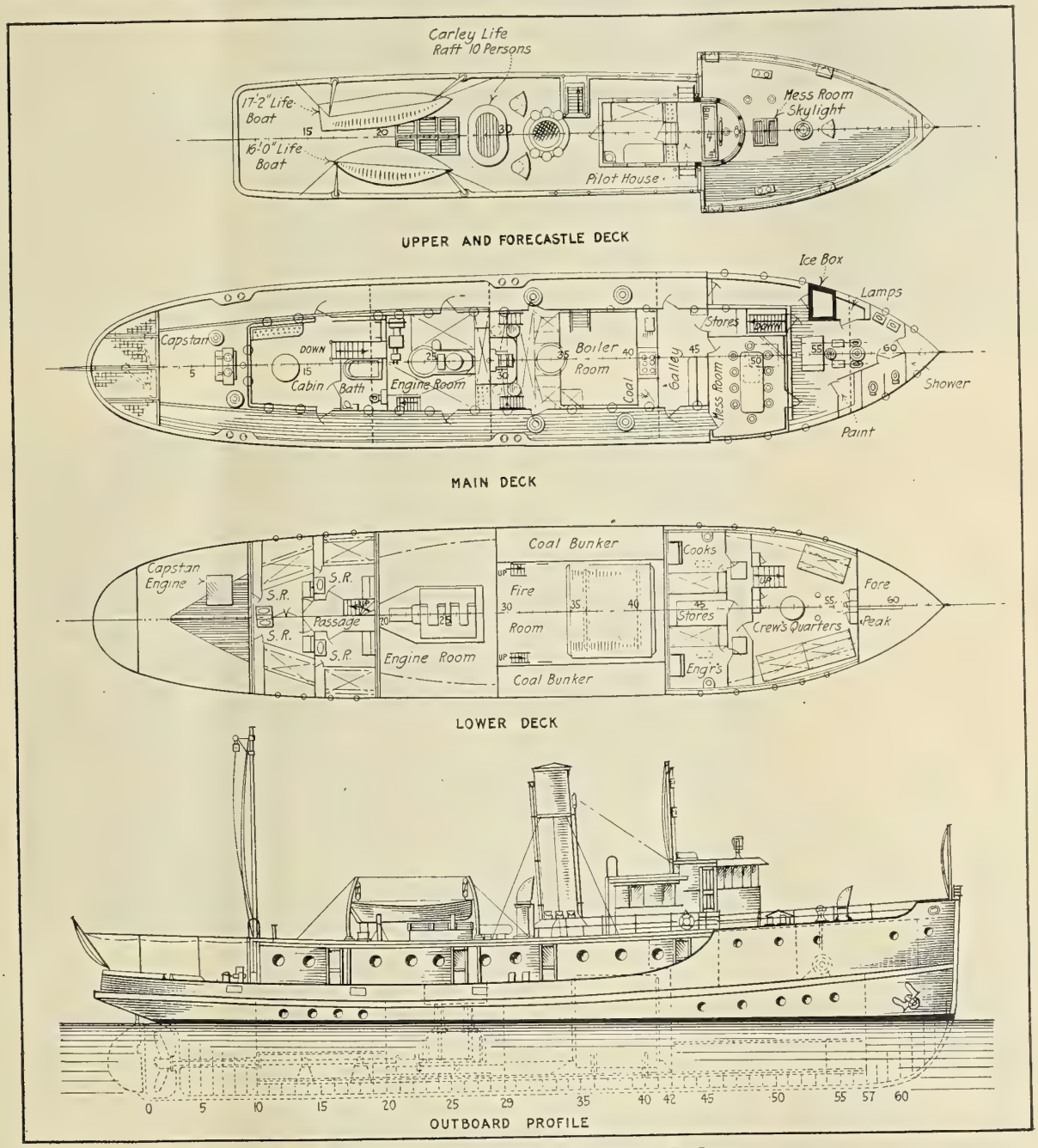
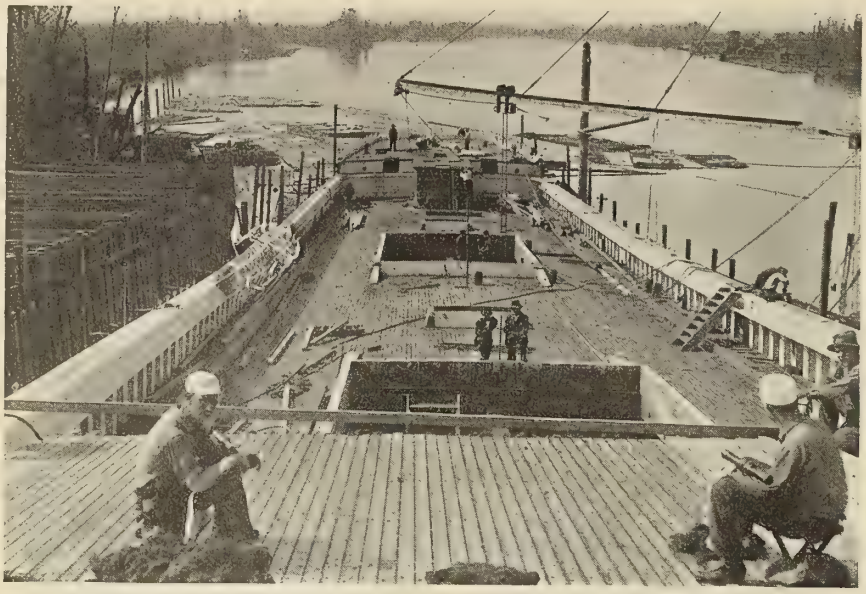


Fig. 3.—Harbor Survey Steamer *General C. B. Sears*

One vertical duplex sanitary pump with 4-inch steam cylinders, 2¾-inch water cylinders and 4-inch stroke.

A feed water heater of the multicoil type is installed in the auxiliary exhaust line.

Steam is supplied at a working pressure of 150 pounds per square inch by a single cylindrical return tube single end boiler, having 1,454 square feet of heating surface and 54 square feet of grate surface. The boiler is 12 feet in diameter by 11 feet 2 inches long, with two Morison corrugated furnaces, 8 inches inside diameter.



Deck of Auxiliary Motor Ship *City of Portland*, as Seen from the Forecastle



View of the Hold, Showing Truss Construction

Auxiliary Motor Ship City of Portland

Wooden Sailing Vessel Built for the Lumber Trade Fitted with Bolinder Oil Engines for Auxiliary Power

BY KENNETH MC ALPIN

During the early part of the war shipping along the Pacific coast took a decided jump and all along the coast the harbors were combed for any and all seaworthy bottoms to be placed in the offshore trade. As the war progressed and the destruction of neutral vessels shortened the available tonnage, the lumbermen in the Northwest began to suffer, for while there was more call for lumber than during the three years immediately preceding the war there was no chance to transport the lumber even at high charter rates owing to the shortage of vessels. It was a happy idea which entered the heads of various coast lumbermen that a wooden vessel provided with sails and a low cost engine would not only obtain high charter rates for cargo but would provide a means of sale for the lumber and would also be the means of building the vessel economically.



Launching of the *City of Portland*

The *City of Portland,* launched at the plant of the St. Helens Shipbuilding Company, St. Helens, Ore., on April 15, therefore marks an epoch in ship construction, as she is the first American built and the largest wooden auxiliary cargo carrier in the world. Her dimensions, as entered in the United States Custom House at Portland, Ore., which is her home port, are as follows: length, 278 feet; beam, 48 feet 3 inches; depth, 19 feet 1 inch; gross tonnage, 1,791, and net tonnage, 1,649.

The *City of Portland* made such a good impression on the surveyors of the Bureau Veritas and the Fireman's Fund Insurance Company that the day she was measured she was immediately classed as A1 for eleven years and insurance may be carried on her for that length of time and longer if ordinary maintenance repairs are made upon her.

Looking forward from the after end where the engines are being installed one is impressed by the amount of stowage room afforded by the truss type of construction used, in which a heavy fore and aft timber and steel



Vessel on the Stocks Before Launching, Showing Location of Propellers

truss, extending from stem to stern and from the keelsons to the single deck, reinforces the hull without interfering with the handling and stowage of lumber. A steel bulkhead divides the cargo hold from the engine room and further strengthens the vessel.

The best of timbers and lumber were used in the construction, and some of the longest single timbers ever used in vessel construction make up a part of this vessel. Some of the lower timbers were sawed one hundred and forty feet long and over twenty-four inches square. From the top of the keelson timbers to the botom of the keel is an even eight feet of heavy timbers, most of them 20 inches by 24 inches in size, and a section from inside to the outside of the vessel through a frame gives an average thickness of 2 feet of solid wood, the planking being 5 inches by 8 inches and the ceiling 16-inch material. With trifling exceptions the vessel is constructed throughout of Oregon fir, two million feet being used in its makeup. Probably nowhere else in the United States save in the Northwest on the Pacific coast could such wonderful timbers be obtained. The masts, for instance, are typical Oregon poles, the tallest being one hundred and thirty-six feet long and thirty inches thick at the base, swelling a bit above the base. This is the foremast, while the three center masts are about the same height, but with a thickness of forty inches at the base. The fifth mast is almost the same size as the rest, and all booms, etc., are of the same Oregon fir. The bowsprit is one piece of timber tapering from a square butt of nearly thirty inches to ten inches at the extreme end. A feature of this boat probably not seen in another ship of her size is a 14-inch slot in the center of the base of the masts, extending from the keelson to the deck to accommodate the reinforcing truss. The masts, spars, booms, etc., were all shaped and finished in the shipyard.

The *City of Portland* has a deep well deck, which will accommodate slightly over one-half of her two million feet capacity cargo of lumber, the balance being loaded below below decks in her spacious hold. The crew's quarters are located in the forecastle, and the comfortable quarters for the captain and officers, as well as the galley and dining saloon, are located in the stern, with an enclosed 8-foot by 12-foot wheel house surmounting the cabin. The captain's quarters consist of a bedroom, living room and bath, while on the other side of the main dining saloon are located the quarters of the three officers and chief engineer with a bathroom between them. The galley is situated so as to serve the main dining saloon and the sailors' mess with the greatest convenience.

This vessel will carry a 7,000 square yard spread of canvas, which will drive the ship at an estimated speed of nine miles an hour, and has as auxiliary power two 4-cylinder Bolinder type semi-Diesel engines, each unit developing 320 horsepower at 225 revolutions per minute and swinging a four-blade propeller 77 inches in diameter and 61 inches pitch. These engines will consume about a barrel of fuel oil per hour, or an estimated consumption of 26 barrels per 24 hours, and will drive the vessel at 7½ or 8 knots, so that the total time of the trip to Sydney, Australia, from the Columbia River will be approximately 28 days. The great saving in cargo space is emphasized by the fact that these engines will take up only 4 percent of the cargo space against 40 percent for steam engines of the same power.

The fuel tanks for the engines are placed alongside the engines and have a total capacity of 1,200 barrels of oil, which provides for a cruising radius of 6,000 miles. In the extreme after end of the boat are two fresh water tanks with a total capacity of 10,000 gallons.

In addition to the propelling engine, the *City of Portland* will have one 66-inch dry back marine boiler which will drive the steam anchor hoist, steam capstan, four double hoist winches and steam bilge pump and will also drive the electric light dynamo when in port.

For the loading and storage of cargo two pairs of cargo booms are provided, one pair on the foremast serving an 18 by 26-foot hatch and one pair on the spanker mast serving a similar hatch forward of this mast. These will enable the vessel to be unloaded from either or both sides at one time, the booms being driven by a separate double winch for each boom. This will greatly facilitate the quick despatch of the vessel, and as cargo space is the greatest need they will not interfere with the sixteen-foot deckload of lumber she will carry.

The vessel will present a very pretty picture under sail, as she is of the bald head schooner rig type and will in a way placate the old seamen who have witnessed the gradual withdrawal of the "windjammers." On the other hand, she will be given even the admiration of the "men in steam" as she carries out their theory as to low cost propulsion and operation.

The *City of Portland* will probably leave for Sydney about June 15 with a cargo of lumber and has been chartered for three trips at high charter rates. She will bring on each return trip a capacity cargo of three thousand tons of coal or general cargo. She has been paced under the command of Captain Olaf Johnson, who has been with the McCormick Company in steam for a long period of time, and previous to that was probably known to marine people in all parts of the world, as he sailed for the Knowland Company in San Francisco for twenty-six years.

The *City of Portland*, as well as three more sister ships which differ but slightly, was designed and built under the direction of Mr. J. H. Price, naval architect, and the details of the management of the vessel are under the authority of Mr. Hewett, port superintendent of the Charles R. McCormick Company of San Francisco, Cal.

The three sister ships of this vessel are now on the ways at St. Helens, as well as two smaller ships for an Alabama firm. A total of twenty-five similar ships are under way at various yards in the Pacific Northwest, and inquiries have come in from Manila, P. I., and as far away as Norway and Sweden in regard to contracts for same.

The total cost of the *City of Portland* will be approximately $175,000 (£36,000).

DUCTILITY OF BARS FOR STAYS AND BRACES IN MARINE BOILERS.—A recent amendment to the Rules and Regulations of the United States Steamboat Inspection Service provides that when the tensile strength of the test piece of bars for stays and braces in marine boilers is more than 63,000 pounds per square inch of section, each test piece that has been reduced in size shall show an elongation of at least 26 percent in 2 inches.

UNITED STATES COLLIER TO BE FITTED WITH DIESEL ENGINES.—The United States collier *Maumee* arrived at the New York Navy Yard, Brooklyn, N. Y., on April 3, having been towed by the United States collier *Prometheus* from the Mare Island Navy Yard, San Francisco, Cal., where she was built, a distance of about 4,000 miles.

The engines for the *Maumee* were built at the New York Navy Yard from plans supplied by the New London Ship and Engine Company, Groton, Conn. Preliminary shop tests of the engines have already been made, and as soon as they have been installed in the vessel an exhaustive series of trials will be carried out at sea.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Reference Library of Naval Architecture

The data and information on naval architecture and allied subjects which are published in periodicals and proceedings of professional societies are of such importance that the engineering department of a shipbuilding concern cannot afford to neglect them; but, on the other hand, there is so much of this material that it is of little value unless readily referred to.

The material to be handled in a reference library naturally comes under two heads; namely, articles, papers, and books in one's possession and those which must be referred to at libraries, etc. Under the first head come such professional magazines as one subscribes to regularly.

DESIGN (Ship)
Calculations for ships forms. D. W. Taylor. Paper before Int. Eng. Congress. Application of formulas. 3000. P-1, IME, 10-15.

Steamship design. Method of determining principal dimensions. H. A. Everett. 4p. IME, 10-15.

Geometrical processes for design of ships framework. Table & plates. W. Engelhardt. ill. 1500. Sch. 11-10-15.

Specimen Card

These should be bound or they will be of little value for reference work. Books and pamphlets should of course also be kept in the handy library with the bound volumes of periodicals. Often one may obtain clippings from other magazines, photographs, sketches, etc., from miscellaneous sources which it is desirable to file. These should be pasted in a good sized loose leaf scrap book in order to preserve them neatly.

The next thing to consider is how to have all the information in these volumes at one's finger's tips. The best index to use for this purpose I have found to be a card index. Three-inch by 5-inch white cards are convenient. Besides the regular alphabetical stops, blank stops should be obtained and labeled with the important topics under the subject of naval architecture and shipbuilding, as Accidents, Armor, Barges, Battleships, Boilers, Cargo Ships, etc. I have been using a typewriter to fill in the index cards, but they can of course also be written or lettered in ink, although this detracts somewhat from their neatness and legibility. A certain article may be entered on a card under a topic and then later another paper on the same topic may be entered on the same card. (See specimen card.) The index card should indicate the following facts about the article or book: Title, author, nature of article, whether illustrated, date, length, where found. In order to get these facts into a few lines on the cards a system of abbreviations should be adopted. Some articles of particular importance require indexing under two topics, as

Description of U. S. Collier "Jupiter"—under Collier, and under Propulsion, Electric.

The above deals only with material in one's own library. This is naturally most referred to and most important, but there are also many articles published which one cannot or does not care to read or consult at the time of publication, but which one may wish to refer to later. The American *Engineering Magazine* publishes monthly a comprehensive list of articles on naval architecture and marine enginering which have appeared in all the world's important periodicals for the past month. This resumé gives the topic under which the article comes, the title, subject matter, author, length (number of words), whether illustrated and where found. An excellent system of abbreviafions is used. I have found it convenient to index these papers and articles in my card index under the same topics, but on *blue* cards, in order to distinguish when referring to the index betwen information which is at hand and that which must be obtained at a public or private library. The resumé will mention the important articles in some of the periodicals which one receives regularly, hence care must be taken not to enter these items on blue cards. The *Engineering Magazine* also publishes this resumé printed on one side of the paper only, so that the items may be clipped and pasted on index cards. It is also important to index books and pamphlets as they are published, and this may be accomplished by consulting the book reviews.

The method of indexing outlined above I have found very simple and useful. It requires only a few hours a month to keep it up to date, and designers and writers on naval architecture and shipbuilding will find it well worth while.

JOHN K. CHRISTMAS.

Easton, Pa.

Classification and Filing of Engineering Data

I note with interest the paragraph in the April number of MARINE ENGINEERING on "Classification and Filing of Engineering Data." So far as I am aware your publication is the only one that has gone so far as to suggest such coöperation. It is to be hoped that the readers and subscribers will respond.

This classifying and filing of engineering literature has been food for much discussion. I have been investigating this field for some time in an attempt to boil down from the many articles appearing in books and society proceedings, to say nothing of periodical references, something which shall aim to be exactly what the results of the suggestions in this article should arrive at, to put in a compilation I am working on for the use of business men and business house libraries.

Of the best articles to be had are those found in Davies' new book on "Engineering Office Systems" and Hauer "Economics of Contracting." Volume 2.

To-day, and for the future, the matter of working out a satisfactory index, and as near an approach to standard

treatment as is possible, is reduced in its magnitude by the presence of so-called special libraries. In these libraries, frequently in charge of specially trained persons, the administrators of these collections have been giving considerable attention and study to this very subject of "Classification and Filing of Engineering Data." That they have solved many difficulties and the experience of these people is of value in this proposed co-ordinating of the classification and filing of engineering literature, goes without saying. In fact these librarians, as they are called, have formed an association for the promotion of efficient administration of engineering collections and allied matters. This association has been organized for five years. It has in its membership some three hundred and fifty odd members representing individuals of repute and firms of high standing, both in this country and several foreign countries. The members of this association, known as the Special Libraries Association, might logically form a committee which shall undertake to analyze the results of the proposed study of classification and

File No. Subject Title

Author
Periodical Date. pages.

Arrangement of Index Card

filing of engineering data for the purpose of submitting, if not standard methods for handling engineering data, at least rational and recognized methods as represented by the light of prolonged study on the part of these specialist librarians in their particular fields.

Such coöperation may be well in the future and possibly such standards as might be proposed would not be universally adaptable. However, I believe it would be worth while working out and the final results printed in some manner, forming thereby a suitable guide for the engineer without the special library at his elbow, and something on which the individual engineer with small office force may found an office "Handbook," which is really what these special libraries are.

In writing the above I had in mind the process carried out by a firm in indexing periodical literature of interest to them. The originator of the idea uses a series of headings, which are in fact nothing more than a skeleton outline classification, and assigns related numbers. Upon finding an article which it is desired to preserve, the person writes in the margin the number corresponding to the subject. The article is then passed on to a clerk, who copies the title under a proper subject suggested by the classification number. This method serves a double purpose (1) of assigning a classification number, or more commonly spoken of outside of libraries, as an index or file number, and (2) a proper reference heading.

For example, supposing you see in a magazine an article on "Marine Steam Turbines." Supposing your classification number or file number is 621.123. You then mark the article 621.123 and place it in the hands of clerk to be written up. The clerk then looks in his index for the translation of 621.123 and finds it means "Turbines, Marine," or "Marine Turbines," whichever form of entry you prefer. The clerk then writes a card with the heading "Turbines, Marine," which would be the more logical as, perforce, in a shipyard all matter is essentially marine. After writing the heading, the clerk copies the title of the article and author, if there is one, just as though he were transcribing it into a letter. Following after that the usual information as to volume and its number and page, etc.

With a form card as suggested it is not a very brainy matter to index periodical literature—or book literature, for that matter.

In reading over some of the many articles on the subject of indexing and filing engineering literature I find that many engineers are making considerable effort in overcoming the difficulty of what headings to use and how to keep those headings uniform. There are at present two possible aids that to me would tend to overcome that difficulty. I have in mind the American Library Association's "List of Subject Headings" and the Library of Congress "List of Subject Headings"—the latter more adaptable to special technical subjects.

In both of these compilations are listed thousands of subject headings found to be suitable for the indexing, or what we call "subject heading" of literature. It does not matter whether these lists were primarily gotten up for libraries because libraries relate largely to books. The subject of a thing is the same whether it is a book, pamphlet, periodical or engineer's note. Experts in their lines have worked on the proper form of entry and wording for these headings. They have worked to make a uniform set of headings. While in many instances they are inadequate for specific divisions of engineering they are not, on the other hand, absolute. The idea of getting up these lists was for uniformity and guidance—something on which to build. The practice in libraries is to use these as guides and modify where needed, and space is left for making suitable notes.

The librarian of H. M. Byllesby, of Chicago, says: "One fundamental and important fact seems to have been omitted in the majority of articles written by engineers upon the subject (indexing), namely, the fact of standardization of library methods for handling library material. Standardization rules have been adopted in practically all lines of engineering, but the engineering profession in general has not been informed that library methods have also been standardized by library experts, and that the vexing problems which they are endeavoring to individually work out, as indicated by the variety of experiments which are written up from time to time, have been tried out, solved and reduced to a working science by library experts."

While I think that the above is rather sweeping, I nevertheless am convinced that by coöperation both sides can gain in reducing the element of handling and filing engineering data to a science. One instance I noted in the reading of these articles that leads me to believe there is an element of truth in Miss Krause's statement, that is, of all the articles I have read only two men had hit upon the idea of indicating on the original, or what we call "Main Card," all other cards made out. So when the publication is removed all cards are taken out and not a lot of dead ones left in, as so many of the engineers claimed. Now, in library work the indicating or "tracing" all cards made for a publication is as old as the card index. By the way, it is interesting to note that a librarian was the originator of the card index.

If you are not already acquainted with the Industrial Arts Index, I believe that publication is an aid in handling engineering literature for all headings that titles are

indexed under might serve as a subject heading list, and the chances are that terms used in it are more universal. In fact, where an office is limited to one subject practically, it would be better than nothing to simply cut out the references of most interest and paste on index card and file alphabetically or by classified order. However, the references would be old, for the publication is issued quarterly.

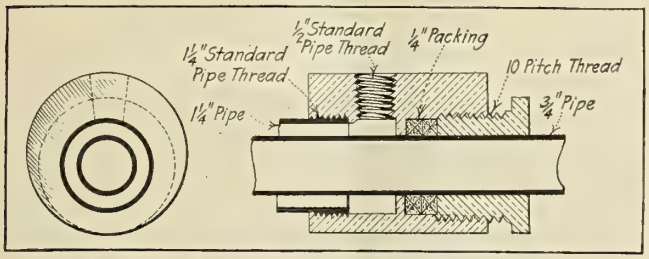
I hope to see this step inaugurated by your publication the means of bringing whatever is of value in library science and service to the service of engineers.

Kenneth C. Walker,
Head Department of Technology.
Free Public Library, New Haven, Conn.

Feed Heaters for Small Boats

Some time ago the question of feed heaters for small boats came under discussion. Now as these boats were in constant use and the coal capacity of the boats is limited, it was considered that it would be a good plan to install heaters, but as no heaters of proper size were found in the market one of the following description was built and installed in each of this ship's boats.

After some study on the subject this type was built. A section of ¾-inch pipe, just a little longer than the width of the boiler, was threaded on each end. Over this was passed a section of 1¼-inch pipe, which gave a clearance of approximately 5-32-inch around between the pipes as the ¾-inch pipe was 5-16-inch smaller in diameter than the inside of 1¼-inch pipe. The 1¼-inch pipe was cut



Sketch of Special Fitting for Feed Water Heater

somewhat shorter than the ¾-inch pipe and was threaded to receive fittings.

Special fittings were machined by the ship's force to conform with the sketch. These were then screwed, one on each end of the 1¼-inch pipe, and glands were packed, after which a tee was fitted on each end and connections were made from tees to the boiler checks and to the feed pumps. Valves were placed on the pump discharge at the pumps, so that when the starboard pump was in use the discharge valve on the port pump was closed and the feed stop on the starboard was also shut. The water from the starboard pump was then discharged through the heater and into the boiler through the port feed check and stop. When the port pump is to be used, the valves were worked just the revese.

After the water connections were made the exhaust of both pumps was connected to one of the special fittings and drains were piped from special fittings on the other end. On this drain line a relief valve was placed and set at about 4 pounds, after which the drains were piped to the engine drain line to the condenser. On this line was placed a valve so that the drains could be run into the bilge in case the boat was in the skids and it was not desired to run the drains into the condenser for the time being.

As no time was to be had for experimenting, full data cannot be given, but such data will be taken and the results will be announced later.

The following facts have been noted since the heaters have been installed:

(a) The amount of coal used has been reduced by about 18 percent.

(b) The grate bars do not burn out or sag as they would under a heavy fire, as a light fire has proven to be hot enough.

(c) The use of a steam jet is not needed nor resorted to to maintin the steam pressure.

(d) The engine seems to run smoother as a steady pressure is maintained.

As the volume of exhaust steam and volume of water to be heated are always in same ratio, the water is heated to the same temperature at all times, varying only as the temperature of the air pump discharge.

F. C. W.

An Expensive Error of Judgment

A peculiar accident, that caused considerable delay and expense to the owners, occurred to a steamer engaged in the coastwise lumber carrying trade. This steamer had a triple expansion engine, with a surface condenser built in the frame. On a recent voyage it was found that extra feed water was entering the boiler in such quantity as to necessitate frequent blowing down. The weather was bad and the chief engineer, supposing that the leakage was through the tubes in the condenser, decided to complete the voyage without stopping.

After some time a number of the tubes began to leak in the front end of the boiler, and about the same time some staybolts in the back connections started leaking. This caused a reduction of the steam pressure and consequent slowing of the engines, thereby delaying the completion of the voyage.

On arrival in port the boiler was emptied, when it was found in a deplorable condition. The engineers were surprised to find an extremely large quantity of grease in it, as well as a salt scale all over the heating surfaces. On testing the condenser by filling it with water a leak was discovered in the bottom of the shell at the low pressure crank pit. As this leak was in a place inaccessible for repair from the outside it was decided to remove the tubes in order to locate and patch it on the inside. On doing so it was found that instead of a damaged shell a drain pipe from the bottom of the shell had corroded away and grease and salt water from the bilges and crank pit had been entering the condenser through the hole. The ship had a list to port all the way up the coast and the hole was sealed by the water in the bilges, so that there was no loss of vacuum, thus accounting for the natural supposition of the engineers that the leakage was through the tubes. Had they supposed that the leakage was through the shell they would have stopped and made temporary repairs, even in the bad weather that prevailed.

Almost four weeks' time was required to scale and clean the boiler and make repairs. Eight staybolts had to be renewed and the tubes in the boiler expanded, tubes removed and replaced in the condenser, in addition to the loss and inconvenience of the delay. Quite an expensive error of judgment!

This would seem to be one of those unusual experiences that prevent a marine engineer's life ever becoming monotonous.

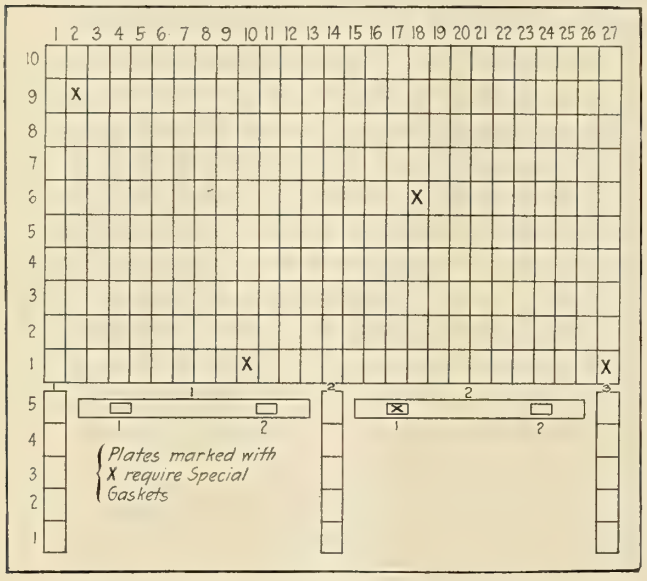
New London, Conn. J. S.

Graphic Record of Poor Header Seats in Sectional Type Boilers

Undoubtedly there are many engineers who have had unpleasant troubles with header handhole gaskets blowing out, the attendant necessity of hauling hot fires and we all would welcome some way to prevent this or reduce it to a rare occurrence.

Gaskets blow out from many causes, such as being improperly placed on the plate seat, not set up tight or not followed up on when the boiler becomes heated. But more often the trouble is due to the seats in the headers being in bad or poor condition, rough and irregular, and in many cases worn and deteriorated away by leaking gaskets, so that in old boilers we have many troubles.

In the plant under my care there are sixteen, 27-header type, Babcock & Wilcox watertube boilers. All are over



Graphic Record Sheet for Header Seats, Boiler No. 1, Front

eleven years old and of course we have plenty of poor seats and headers. These are all located on a graphic record.

When it becomes necessary to clean the interior of the tubes we remove all the plates from the front headers, uprights and cross boxes, and from the two lower rows in the back headers. Our schedule of cleaning is to allow each boiler to steam on an average of 1,000 hours. This has meant that about every six weeks we have 8 boilers to clean and it is therefore necessary to remove and replace 2,784 handhole plates. In cleaning the boilers, removing and replacing the handhole plates, we have to use the firemen and coal passers, and of course all of them do not possess the ability to judge whether a seat in a header is poor enough to need a special gasket or attention, and in putting back plates they are liable to put in plates with common gaskets where ones of special make should be used. This is prevented if we know the location of all poor seats requiring special gaskets.

The graphic record is a plan of the boiler headers, uprights and cross boxes, as shown in the sketch. Each header and plate hole has a number, all being numbered from right to left and bottom to top, the same on each boiler. Now let us consider that we have just completed the cleaning of a boiler and closed it for testing. We fill it with *hot* water (this heats the gaskets and headers and they can be followed up) and we pump up the pressure, watching all plates for leaks. We find that some start leaking and will not make up tight, and perhaps we have some blowout. We mark all these, and empty the boiler, remove them and examine the plate, gasket and seat, and if we find that the seat needs a special gasket the location of it is at once placed on the graphic record of this boiler.

Now the distinct advantage of this method of recording these poor seats is that the next time this boiler is cleaned and is ready to have its plates replaced the graphic record is consulted and all poor seats are found by it and special gaskets placed on them by a competent man, and the firemen are then allowed to proceed closing all other plates. This method has saved the plant a great deal of time, trouble and expense, for even after many boilers were closed and tested with hot water up to the working pressure and all plates were found tight, we have had some gaskets blow out after the fires were lighted and steam pressure raised. Such plates as these were recorded and we now have nearly every poor seat in the boilers located and have seldom experienced the necessity of pulling a fire for a leaky gasket. This, of course, means saving coal and water.

For special gaskets, we use the regular handhole plate gasket wrapped with asbestos wicking soaked in red lead. If this sort fails to hold tight (which very seldom happens), we place a regular gasket on the plate and apply a thick coating of Smooth-on iron cement quickly and carefully place this in the header, set it up tight and bake it with a torch.

It has been my experience that with careful cleaning of the header seats and the application of a small wash of graphite paste one can preserve old header seats so they will last as long as the drum of the boiler will last.

C. H. W.

Analyzing a Marine Steam Plant*

The analysis of a steam plant begins with the selection of proper fuel, as outlined in the last issue. The next logical step is the proper use of this fuel. The analysis will be confined to the use of coal for the present, since the next letter is to be devoted exclusively to oil.

The fundamental principle of furnace design and proper combustion is that the air must pass through the combustion zone; not around it, or over it, nor under it, but through it. The combustion zone consists of two parts; they are the fuel bed and the flame space. The flame space is sometimes known as the combustion chamber. Hard coal requires very little flame space, because it has very little flame and such as there is exists mostly in the fuel bed. Soft coals require large flame space. There are two kinds of flame, that caused by the combustion of volatile products, which give a white flame, and that caused by the combustion of the gas, carbon mon-oxide, which gives a blue flame.

The process of combustion taken out of the text books and put into a Scotch boiler is about as follows with average coal. Suppose that we are dealing with an incandescent bed of fuel six inches deep, working at full load. Such a bed consists of pure carbon and ash, since all volatile hydrocarbons have been driven off, or the mass would not be incandescent. The air comes up through the grate bars and passes through the fuel, oxidizing the carbon, and thus creating heat. If plenty of air is going through, the products of combustion are carbon dioxide and other gases which we will consider later. If there is not enough air going through, as when the fuel bed is

*For previous letters on this subject see April and May issues.

too heavy or the draft is poor or the boiler is being crowded, carbon monoxide is formed, which means that the fuel is only half burned, and the monoxide gas will take fire and burn further if it finds air while it is hot. If a blue flame appears on the surface of the fire bed when the furnace doors, or the shutters in the door, are opened, it means that the fuel is not getting air enough. This can be remedied by increasing the draft or by admitting air above the bed through the fire door shutters.

When fresh coal is thrown in on the hot fire bed, the first action of the heat is to warm up the new coal. This distils off the volatile hydrocarbons or tars in the form of green smoke. These will burn if supplied with air above the fire bed, ignited by some of the fire bed left uncovered, or by white hot brick work. If, on the other hand, this vapor is kept cool by the iron sides of the furnace and does not meet an incandescence to ignite it, the calorific value of the volatile constituents will all be wasted in the form of dense volume of smoke up the stack. With a hard coal running 20 percent volatile matter, this loss would be immense, and with a soft coal running 35 percent volatile matter the losses would be so large that they would attract attention.

If too much air is admitted, another loss occurs which can be very large. No more air should be admitted than is necessary for combustion because it costs just as much to heat air as to heat water. To illustrate: Each pound of pure carbon requires about 12 pounds of air for its combustion. The calorific value of fuels is usually calculated by taking into consideration the amount of carbon and hydrogen contained, but this formula is disputed by some, and a much simpler one is as follows: The calorific value of pure oxygen is 7,760 British thermal units, no matter what it is burned with. Air consists of 23 percent of pure oxygen by weight. We know that it takes 8 pounds of oxygen or 36 pounds of air for each pound of hydrogen in the hydrocarbons of coal. We know that it takes 2 2-3 pounds of oxygen or 12 pounds of air for each pound of carbon in the fuel; therefore, after a glance at the chemical analysis of a fuel, arithmetic will give the theoretical amount of air required. Practically, from 12 to 12½ pounds of air are required for the combustion of average coal. One pound of air is about 12.4 cubic feet, or a total of about 150 cubic feet of air required for each pound of fuel. Air requires about one-quarter of the heat that water does to raise its temperature one degree. Suppose that there is twice as much air going through a furnace as should (there is often five or six times as much as should be). This air is discharged from the stack of a Scotch boiler at an average temperature of 1,000 degrees F. It may be taken from the fireroom at 100 degrees. This is a total rise of 900 degrees. For twelve pounds of air, this gives twelve times 900 times one quarter, or 2,700 British thermal units lost per pound of coal by admitting too much air. As the coal has a calorific value of, say, 11,000 British thermal units, the loss amounts to about 26 percent for every 100 percent of excess air, a prolific and common source of loss.

If it is desired to burn low-priced coals, which carry large percentages of ash and are of small sizes or full of dust, it is necessary that the boilers are not crowded; otherwise cleaning fires becomes such a burden and the condition of the firerooms so intolerable, that the men rebel, and their efficiency is lowered. It has been demonstrated time and again in all branches of industry that high-grade help well treated pays the best dividends. Ample boiler power lowers the rate of combustion and prevents the formation of unmanageable amounts of clinker on the grates.

If a great deal of soft coal is burned an arch of fire brick over the bridge wall will assist in keeping the green gases ignited and prevent smoke. It is also a good plan to line parts of the combustion chamber with brick for the same reason, but the brick should not be more than one thickness so that a portion of the heat may be transmitted through to the heating surface beneath and thus make use of the heating surface, as all marine boilers have a deficiency of heating surface compared to the load they carry. This system can hardly be applied to ferry steamers because the brick work retains so much heat that the boiler makes steam long after the fires are out.

The object of "working" a fire, breaking it up with slice bars, etc., is to prevent a solid bed forming which would prevent the air from passing through. This melting together is caused by two elements; first, the molten ash or slag which accumulates and tends to seal the air passages, and second the tarry constituents which tend to melt and flow before being evaporated, leaving the coke behind; therefore, a coal high in volatile matter and also high in ash will be hard to fire and tend to run together.

There are several ways of working fires. The most wasteful way and the hardest on firemen is simply to throw in coal regardless of other considerations. A better way is to shovel into the front of a furnace and shove the coal back after a few minutes while working the fires. The reason is that the volatile constituents are kept hot and ignited by the fire bed in the back half of the furnace instead of escaping as smoke and vapors. By the time the coal is shoved back it is mostly coke and the vapors are so reduced in volume that they will be burned in the ordinary course of combustion. Between the time of firing and working the fire the door shutters should open so as to supply air for the combustion of the vapors above the fire bed, but they should be closed after the charge is coked to prevent an excess supply of air. Another way of firing is to fire only a little at a time, say two scoops full, and fire oftener. The charge is spread all over the furnace and the door shutters kept a little open all the time so as to make sure that the vapors burn. Another way is to fill up one side of the furnace at a time and open the shutters in the door on the opposite side, if a two-door furnace, or to open them halfway in a one-door furnace. This method is not so economical because some of the vapors in the rear of the furnace will escape without being burned.

The object of cleaning fires is to remove the clinker without removing any more fuel than is necessary. With a poor coal, practically the entire fire is removed, as all the fires in one afternoon must be cleaned together for practical reasons. This is the most trying part of a marine fireman's work and the cause of most of the administrative trouble in firerooms. Criticism should not be made of the character of firemen in general because they are just what conditions have made them. In an oil-burning fireroom, one does not find the character of the fireroom men inferior to any one else aboard the ship, because it is comfortable work; so anything which ameliorates the horrible conditions of the average fireroom raises the character and efficiency of the men aboard. There is no scientific method of cleaning a fire, patience and a good vocabulary being the necessary requirements in separating clinker from the grates. Ash ejectors, hoists, etc., all help, but the best returns are gotten from providing plenty of boilers, so that fair headway can be made when one-quarter or more of the fires are on the floor plates instead of the grates. The greatest help of all is to buy coal that is low in ash. Cleaning fires, then, while no picnic, does not interfere seriously with the schedule. Many a 12-knot steamer of good boiler capacity can pass a 14-knot boat whose boilers are over-

worked on a long run because of the difference in cleaning fires each watch or a difference in coal.

When an ash pan door is one-quarter open it admits the same quantity of air as when it is wide open, and to cut down the supply the door should be open only an inch or one-half inch. Air may be admitted anywhere where there is incandescence and something to burn, but not where things are black hot, no matter whether there is smoke or gas there or not. The proper amount of air admission is ascertained from the appearance of the stack and from the analysis of stack gases. Air should be admitted whenever there is smoke, especially above the grate bars, but the smoke will not burn unless it passes through a zone of incandescence. After the smoke disappears the air may be cut down until a little smoke appears, but some caution must be used, because if the fuel bed be all coked and hot there will be no smoke under any conditions, and a deficiency of air causes the fuel to half burn and give off monoxide, which is half burned gas instead of dioxide, which is wholly burned gas. Both gases are invisible, hence there is no knowledge of the loss, except from a chemical analysis by an apparatus which can be attached to the stack. This apparatus may be in the form of a simple tube, which can be purchased for 75 cents (3/1½), and any engineer can use it; or it may be an automatic recording device making an automatic test every fifteen minutes and recording the results on a dial. In any case the test depends upon the principle that when perfect combustion is taking place from 13 percent to 15 percent of carbon dioxide is formed. If the combustion is imperfect, this percentage is reduced air admitted, the products of combustion show less than in proportion to the imperfection. If there is too much the proper amount of carbon dioxide, but no carbon monoxide. If too little air is used, the products show less than the proper amount of carbon dioxide, but also a proportion of carbon monoxide, or half burned gas. The apparatus, whether of the elaborate or simple type, depends upon the principle that certain chemicals easily obtainable will absorb each of these gases without the others. Many kinds of apparatus are available for the analysis of the products of combustion. None of them costs as much as even a cheap indicator, and far more can be learned from the stack in the way of economy than from indicator cards. The analysis will show just exactly what the furnaces are doing. Analysis may be made also for hydrogen, oxygen, sulphur, moisture and sulphuric acid. Any practical man can make the tests by using the chemicals and following directions, and simple books can be procured which explain the meaning of the analysis.

Excess air causes high stack temperatures, because the excess of air takes heat from the furnace and carries it out the stack instead of giving it up to the boiler. The reason that the heat is not given up to the boiler is that the hot air is lower in temperature than the products would be alone and the heat does not flow into the boiler so fast. The temperature of a stack should be about 600 degrees F. on a good watertube boiler to 1,000 degrees F. on a crowded Scotch boiler. If the temperature in the stack is more than these figures and there is not excess air in the furnaces, either the boiler is being crowded or else it is deficient in heating surface.

There are several means of possible improvement in fireroom conditions, but progress seems to be slow along this particular line of endeavor. It would probably pay some large steamship line to spend some money experimenting with possible devices. Chain grates look promising, if adapted to marine boilers or even if the boiler is adapted to the grate, if necessary; a watertube boiler and chain grate is by no means an unknown combination, and it would elminate the dreadful task and loss of cleaning fires. Down draft Dutch ovens, made after the general design of a gas producer discharging ash from the bottom, have been used on shore with great success and burn soft coals without smoke. Actual gas producers are in operation in Mexico (or were), which feed hot unscrubbed gas to steam boilers.

The use of oil fuel is one of the most rational solutions for conditions in a marine fireroom. Standards of fuel oil are now obtainable all over the world which are as safe as coal, everything considered. It requires less than half of the storage space for the same calorific value and burns with higher efficiency. It dispenses with the bulk of the firemen and their quarters. It is handled, loaded and unloaded without soiling the ship and has numerous lesser advantages. There are many kinds of fuel oil and considerable technique to its use, all of which is discussed at length in easily obtainable books on the subject. The general principles of combustion of oil are the same as already described, and the principles of its use follow in a general way the principles for the combustion of the volatile hydrocarbons in coal.

The next letter will analyze the conversion of heat into pressure by the boiler, and possible economies will be discussed.

E. N. PERCY.

RAILROADS TO RETAIN STEAMSHIP LINES.—The Interstate Commerce Commission has rendered a decision in the applications of the Florida East Coast and the Atlantic Line railroads, under the Panama Canal Act, to continue the operation of the Peninsular & Occidental Steamship Company, whose vessels ply between Tampa, Key West and Miami, Fla., and Havana and Nassau. After the revision of the rates by the railroads, the Commission held that the operation of the steamship company is in the interest of the public, and of advantage to the convenience and commerce of the people.

REINFORCED CONCRETE DOCK AT HOUSTON, TEXAS.—The city of Houston, Texas, has adopted the Cleveland Dock Engineering Company's design for a marginal dock in Buffalo bayou. The dock is to be 777 feet long and about 45 feet wide, consisting essentially of a reinforced concrete beam and girder floor supported out over the water on piles with a buttress wall on the outer margin to retain the fill. It is a freight dock for general purposes and freight can be handled both by crane equipment and by ramps. The dock will cost $298,500 (£61,250), with the addition of about $25,000 (£5,125) for cranes and ramps.

LAKE ERIE ORE DOCK TO BE ENLARGED.—The Pittsburgh & Conneaut Dock Company, a subsidiary of the United States Steel Corporation, will build a new steel and concrete dock equipped with eight ore-handling machines and two 700-foot conveyor bridges at Conneaut, Ohio, on the site of the company's present dock. The new dock will be 2,050 feet long and 1,015 feet wide, with a storage capacity of 8,800,000 tons of ore. Berthing space for four ships at one time will be provided. The construction of the dock will begin about June 1.

LOSS OF LAKE STEAMER S. R. KIRBY.—The first serious disaster of the season on the Great Lakes was the breaking in two and sinking in Lake Superior of the Northwestern Transportation Company's steamer *S. R. Kirby*, with the loss of her crew of twenty men. The vessel was of 2,338 tons and was built in 1890.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, and defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Riveting on Oil Tank Vessels

Q.—I am very much interested in the efficiency of riveted joints, the manner of spacing riveted joints and so on, both in boilers and fuel tanks for sea-going ships. I have noticed that in most oil-burning foreign ships chain riveting seems to be in vogue, while on our own coastwise vessels staggered riveting is the prevailing style. Any information on the above will be gladly received. R. T.

A.—The rules of the principal ship classification societies both here and abroad require the seams and butts of centerline bulkheads, transverse bulkheads, and outside and deck plating in way of oil compartments to be not less than double, chain riveted. Staggered riveting should not be used for shell or oil compartments, and is not so done in new construction. Sometimes a vessel not originally intended to carry oil is modified into an oil carrier or oil burner, and as the riveting which was sufficient for watertightness is insufficient for oiltightness, augmentation of it becomes necessary. It is probable that the instances quoted have some special reason of this sort to account for the riveting being staggered.

Steam Velocities for Short Stroke High Speed Marine Engines

Q.—Would you kindly inform me through the columns of your valuable journal the best steam velocities for short stroke, quick revolution marine engines running at a piston speed of 700 feet per minute to give maximum horsepower? The velocities required are: main steam, high pressure port opening, high pressure port exhaust, intermediate pressure port opening, intermediate pressure port exhaust, low pressure port opening, low pressure port exhaust, exhaust pipe. R. R.

A.—If the engine operates on a boiler pressure of 200 pounds or over the following values are recommended:

Main steam (3 inches to 12 inches diameter), 6,000 to 7,500 feet per minute (velocity increasing with diameter).

High pressure port opening, 6,000 to 6,500 feet per minute (if passages are straightest possible).

High pressure port exhaust, 5,000 to 5,500 feet per minute.

Intermediate pressure port opening, 7,000 feet per minute.

Intermediate pressure port exhaust, 6,000 feet per minute.

Low pressure port opening, 10,000 feet per minute.

Low pressure port exhaust, 7,500 feet per minute.

Exhaust pipe, 6,500 feet per minute.

If the steam pressure is less, you may be forced into using higher values with the attendant greater loss due to wiredrawing. Seaton† suggests these values:

Main steam: 8,100 feet per minute.

Mean of maximum valve openings: High pressure, 7,500 feet per minute; intermediate pressure, 9,000 feet per minute; low pressure, 12,000 feet per minute.

Ports during exhaust: High pressure, 5,800 feet per minute; intermediate pressure, 7,200 feet per minute; low pressure, 8,600 feet per minute.

Exhaust pipe of passage from one cylinder to next: High pressure, 4,500 feet per minute; intermediate pressure, 5,500 feet per minute; low pressure, 7,000 feet per minute.

Ports during exhaust for light high speed engines: High pressure, 5800 feet per minute; intermediate pressure, 8,600 feet per minute; low pressure, 11,500 feet per minute.

Multi-Stage Impulse Turbines

Q.—Is not the De Laval turbine a single wheel turbine with all the expansion taking place in one set of nozzles? We have had a discussion in which I have held the above to be true, and the other side claims to have seen De Laval turbines with several stages each with a set of nozzles giving a pressure drop and with one wheel in each stage. Will you please decide the question for us, and greatly oblige? T. E.

A.—The so-called De Laval type of turbine as originally brought out was a single stage, single wheel turbine with the entire pressure drop taking place in the one set of nozzles. This was necessarily a turbine with extremely high blade velocities, and was usually attached to the machine it was to drive by means of reduction gearing. The patent rights covering the basic characteristics of steam turbines have proven of but doubtful value of recent years, possibly due to the difficulty of convincing a non-technical jury that the technical details discussed are important; at any rate, there has been a gradual tendency of the various turbine manufacturers to depart from the specific type which they first manufactured and to modify its fundamental characteristics to meet the needs of the various units to be driven, and we find the De Laval Company now manufacturing turbines of the "single stage," "multi-stage" and "velocity stage" types, and all, of course, De Laval turbines, though the first-mentioned is the only one that closely follows the original turbine of De Laval. The De Laval "multi-stage" turbine has several stages with a pressure drop to each stage, and the velocity thereby produced abstracted by one wheel, thus simulating the original Rateau type. The "velocity stage" type issued by the De Laval Company has a single pressure stage in the nozzles of which the total expansion of the steam occurs with the kinetic energy of the jets abstracted by passing through two or three sets of moving vanes with stationary vanes between, much as was done in the early Curtis type.

Effect on Steam Consumption of Throttling Dry Steam

Q.—Will you please tell me if, when steam is throttled for the sake of superheating it, there is a gain or loss in the steam consumption? To take a specific case, suppose that steam comes from the boilers practically dry at 260 pounds absolute, and that it is then throttled down to 240 pounds absolute, in which condition it passes directly to the high pressure cylinder. E. B.

A.—Throttling steam the amount you indicate would have but a very slight effect upon the steam consumption of the engine. Theoretically there would be a slight loss, as the thermal efficiency is less in the throttled condition shown by the following computation, but this loss might be counteracted or even more than counteracted by the diminution of the effect of initial condensation, so that the final effect upon steam economy would have to be deter-

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

† Marine Engineering Rules and Tables. Seaton and Rownthwaite.

mined by direct tests. The loss in thermal efficiency is found by computing the efficiency for the ideal or Rankine engine, operating between the pressures given, but with the heat contents at both upper pressures the same which would be the case for a throttling reduction.

In any case, the resultant effect will be very small. Assuming a back pressure of 4 pounds absolute, the efficiency of the Rankine cycle equals

$$\frac{H_1 - H_2}{H_1 - q_2}$$

where H_1 = heat content, initial.
H_2 = heat content, final.
q_2 = heat of liquid at lower pressure (4 pounds absolute).

With dry steam at 260 pounds absolute

H_1 = 1,202 B. T. U.
H_2 = 921 B. T. U.
$H_1 - H_2$ = 281 B. T. U.
q_2 = 121 B. T. U.

$$\text{Efficiency} = \frac{281 \times 100}{1{,}081} = 26$$

With steam throttled from dry at 260 pounds to 240 pounds the heat content H_1 remains the same, and at $P = 240$ and $H_1 = 1{,}202$, the superheat is 4 degrees approximately. H_2 then is for admission expansion 926 B. T. U. and the efficiency is

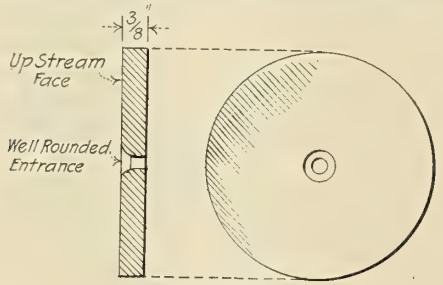
$$\frac{1{,}202 - 926}{1{,}202 - 121} = 25.6 \text{ percent,}$$

which is 0.4 percent less than the first condition.

Steam Consumption of Auxiliaries

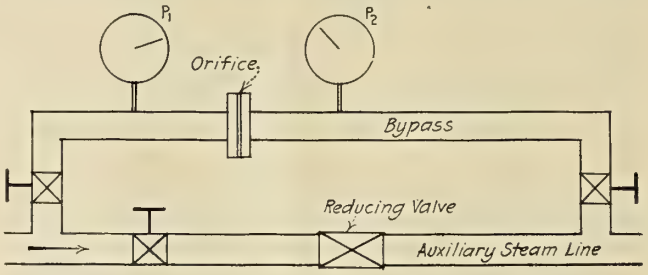
Q.—I have been interested recently in making some economy trials to show the effect of different methods of firing. These have been handicapped by the necessity of running them without interfering with the regular operating schedule of the ship, and, of course, have been made by careful observations of the coal consumption. I have arrived at a place now where it is very desirable that I segregate the coal used for the auxiliaries from that used for all purposes, and I believe the best way of doing this will be to determine the steam consumption total and that for the auxiliaries. The total steam I can get by a meter in the main feed line, but the steam used by the auxiliaries is proving more difficult. Can you suggest a means of obtaining the steam used by the auxiliaries? Have you had experience with any of the steam meters on the market which would warrant an expression of your opinion as to their suitability for this work? Any suggestion you may have will be very welcome to an old subscriber. F. M.

A.—I do not believe that any of the commercial meters for steam will give you as good satisfaction as an ordinary



Sketch of Orifice

curved entrance orifice in quarter or half-inch boiler plate, provided the auxiliaries are operated from a reduced pressure steam line. I have used this aboard ship and in the laboratory, and with a pressure drop such that the ratio $\frac{P_2}{P_1}$ is not greater than 0.85, there should be no difficulty in obtaining an accuracy of at least 2 percent. If there is a reducing valve in the auxiliary steam line, pipe a by-pass of the same size pipe around the reducing valve, and fit this by-pass with a flange connection at the middle of its length. Between these flanges insert the orifice, which can be made of boiler plate with a carefully drilled hole in it. The *upstream* side should be rounded off as in the sketch. Calibrated gages should be tapped into the line just upstream and downstream from the orifice, and readings should be taken at one- or two-minute intervals. The quantity of steam flowing through the orifice will then be given by the following formula, due to Grashof. The area of the hole should be determined by micrometers, and if the fluctuations of pressure are not large the accuracy of the determination will be inside of 2 percent. Below are given a table of the factors to be used in the equation,



Plan of Auxiliary Steam Line with By-pass for Orifice

a plot for the numerical solution of the equation, and sketches of the orifice and the manner of its installation. If the auxiliaries operate on full boiler pressure and the pressure drop is not available it is possible to put the orifice in the exhaust line just before the condenser, and to operate the auxiliaries at an augmented back pressure, but the method is not as satisfactory.

$$w = \frac{a\,P_1^{.97}}{60} \times C$$

w = weight of steam flowing in pounds per second.
a = area of orifice in square inches.
P_1 = initial steam pressure, pounds per square inch absolute.
P_2 = final steam pressure, pounds per square inch absolute.
C = constant from table.

Ratio $\frac{P_2}{P_1}$	Vol. of C.
Less than .58	1.0
.60	1.0
.65	.99
.70	.96
.725	.94
.75	.91
.775	.89
.80	.85
.825	.81
.85	.77
.875	.71

TRAMP STEAMERS OF JAPAN.—According to a consular report from Yokohama, Japan is credited with 272 tramp steamers, displacing more than 1,000 tons each, their combined tonnage amounting to 715,012 tons. Of this number, 112 with a total tonnage of 249,258 are operated by the owners themselves, while 160 with a total tonnage of 465,754 are chartered.

REOPENING OF THE PANAMA CANAL.—After being closed to traffic for seven months the Panama Canal was reopened on April 15, fifteen ships passing through the canal on that date. On April 16 ten vessels and on April 17 eight vessels made the passage, among the latter being the *San Juan*. This was the first Pacific Mail ship to use the Canal. The deepest draft vessels going through the canal during this time was 28.3 feet.

Marine Articles in the Engineering Press

Lighting of Ships—New Vessels—The Screw Propeller —Geared Turbine Machinery—The Cruiser Stern

The Lighting of a Passenger Steamer.—By H. T. Spaulding. This paper introduces the subject by a brief historical sketch of past and present practice in marine lighting. The lighting requirements of a passenger boat are discussed and compared with similar installations ashore. To illustrate how these requirements can be satisfied, the author describes the lighting system designed by him in co-operation with the architects for the steamer *Noronic,* a lake passenger boat, and gives the results of illumination tests in some of the more important portions of the vessel. In conclusion, it is recommended that a departure be made from the ordinary boat lighting systems so current at present, and it is urged that a closer relationship between marine architects and illuminating engineers be established. 8 illustrations. 2,500 words.—*Transactions of the Illuminating Engineering Society,* September.

Passenger and Cargo Steamer Novocastrian.—Built by Messrs. S. P. Austin, Ltd., at the Wear Dock Yard, Sunderland, to the order of the Tyne-Tees Steam Shipping Company, of Newcastle-on-Tyne, for Continental trade. The vessel is 245 feet long overall 34 feet beam and 16 feet 6 inches depth, molded to upper deck, with a gross tonnage of 1,151 and a deadweight carrying capacity of 1,170 tons on a draft of 15 feet 7½ inches. The article describes the structural details, passenger accommodations, life-saving equipment and working arrangements. Propulsion is by a triple expansion engine of 1,500 indicated horsepower, with cylinders 21½, 35 and 59 inches diameter by 39 inches stroke, supplied with steam at a working pressure of 180 pounds per square inch from two Scotch boilers, with a total heating surface of 4,281 square feet. The propelling machinery was supplied by Messrs. Richardsons, Westgarth & Company, Ltd., Sunderland, and the vessel made a speed of 13½ knots on trial; subsequently she was mined and sunk in the North Sea. 6 illustrations. 2,000 words.—*The Shipbuilder,* March.

The Lighting of Ships.—By H. A. Hornor. This paper describes the practical methods of lighting ships in the United States at the present time. The two-wire system of distribution of electricity is generally adopted in merchant vessel practice. The question of insulation and the chemical problems relating to the effect of salt air and salt water upon the materials used in electrical equipment require the greatest care for a practical solution. Generating sets range from one kilowatt, used on small motor boats, to 300 kilowatts, used on battleships. For merchant vessels the prime mover is usually a steam vertical reciprocating engine, chosen on account of its reliability. The steam turbine has been developed as a prime mover, but opinions differ as to their use. Geared turbines have not yet been given a trial in merchant service and the larger units now building for the navy have not yet passed their shop tests. It can be foreseen, however, that probably weight and economy of operation will result from service trials, if the high speed turbine and the reduction gear can withstand the vibration inherent in a ship's structure when under way. The question of searchlights, running lights and night signaling are discussed fully and the current practice in the use of fixtures is outlined. 7 illustrations. 4,300 words.—*Transactions of the Illuminating Engineering Society,* September.

Geared Turbine Propelling Machinery of the S. S. Northumberland.—A series of complete illustrations, showing the geared turbine propelling machinery of one of several vessels fitted by the Wallsend Slipway & Engineering Company, Ltd. The turbine machinery is designed to develop 7,700 shaft horsepower in ordinary service conditions and 9,600 shaft horsepower under trial conditions. The vessel, built by Messrs. Swan, Hunter & Wigham Richardson, Ltd., of Wallsend-on-Tyne for the Federal Steam Navigation Company, is arranged for twin screw propulsion, each line of shafting being driven by a set of Parsons geared turbine machinery consisting of a high and low pressure turbine working in series and coupled to the pinion shafts by flexible couplings, the pinions being seated one on each side of the gear wheel, which in turn is coupled direct to the propeller shaft. The astern-going turbines are incorporated in the exhaust end of the low pressure turbine casings. Steam is supplied under forced draft at a working pressure of 190 pounds per square inch from eight single-ended Scotch boilers, 6 of the boilers being fitted with Schmidt's superheaters, designed to deliver the steam to the turbines at a superheat of 125 degrees Fahrenheit. The article describes briefly the auxiliary machinery in connection with this installation. 10 illustrations. 1,600 words.—*Engineering,* March 17 and 24.

The Screw Propeller.—By Sir Archibald Denny. This paper describes briefly some of the results of model experiments with propellers at the Denny experimental tank. When the Denny experimental tank was opened in 1883 ship models were dealt with first, but shortly afterwards experiments were begun with model screw propellers, both behind models and without models in front of them. Curious differences between real and apparent slip were observed, and an attempt to throw some light on this was made by experiments with a series of screws and a corresponding series of disks and sectors of the same diameters. For the complete disk the resistance increases with increase of revolutions per minute. When the sectors were not revolving the resistances were in proportion to that of the whole disk in proportion to their respective areas. Other factors discussed in this paper included the effect of the following wake and cavitation. As a word of warning, the author expresses the opinion that the ordinary uniformly pitched propeller of the usual shape and section of blade made of suitably pitched diameter and ratio of projected to disk area, cannot generally be improved upon by any unusual design of propeller. The author also emphasizes the fact that the only trial which is really useful for the future study of propellers is the progressive trial with clean bottom surface of ship carried out on a series of runs on a proper measured mile with sufficient depth of water. 3 illustrations. 4,000 words.—*Transactions of the Institute of Marine Engineers,* November.

The Composition of the Exhaust from Liquid Fuel Engines—By Second Lieutenant Robert W. Fenning, R. E. (T.), B. Sc., D. I. C.—This paper describes a method of constructing exhaust gas charts for suitable fuels without the use of an engine and gives the results of numerous experiments consisting of the preparation of mixtures of air and vaporized fuel in known proportions and the explo-

sion of some of the mixtures in a small explosion vessel, the products of which are completely analyzed. The work was undertaken also to increase the evidence as to the composition of exhaust gases, especially with reference to the products of which are completely analyzed. The work ures. Various fuels were employed, the considerations affecting their choice being their volatility, their suitability for motor spirit and their purity. Those selected were hexane and benzone as standard fuels, petrol and commercial benzol as commercial fuels. It was found that with volatile fuels there is but little difference in the composition of the products of combustion resulting from air fuel mixtures in a small explosion vessel or in an engine cylinder in spite of the conditions being so dissimilar. A very small quantity, if any, of unsaturated or saturated hydrocarbons is present in engine exhaust gases. The hydrogen constituent in exhausts from strong mixtures is an important item and increases in value rapidly with increase in mixture strength. The ratio of air to fuel in the original mixtures can be calculated with a considerable degree of accuracy from the composition of the exhaust gases. The reliability of Dr. Watson's method and apparatus for measuring the air and fuel supplied to an engine is once more demonstrated. 9 illustrations. 5 tables. 10,000 words.—*Transactions of the Institution of Mechanical Engineers,* March.

Cruiser Sterns on Merchant Ships.—A consideration of the claims put forward for the adoption of the cruiser type of stern on merchant vessels to reduce the resistance of the hull. It is stated at the outset that the result of the experiments of Froude, corroborated by the subsequent work of Taylor and others, as to the relative effects upon resistance of the shape of the forward and after bodies, has been to lay down the general law that resistance for a given displacement and length of ship depends almost wholly upon three factors: (1) shape of the curve of cross sectional areas; (2) the breadth of the ship, and (3) the fineness of the forward waterline. It is clear that the underwater shape of the section may be varied within wide limits for the whole length of the ship without detrimental effect, but it is also well established that the shape of the forward body is more important in determining the resistance than that of the after body, so that when we apply ourselves to the influence upon resistance of changes of section made wholly in the after body it is not reasonable to suppose that any improvement of a large order is to be looked for. As this is exactly what is claimed in some quarters for the cruiser shape of stern it is evident that the contention does not rest on a very secure foundation. Taylor's experiments with a series of models in which the most radical changes possible were made in the after body sections, showed that the extreme variation possible, without regard to real practical ship-shaped forms, produced changes of resistance of the order of only five percent. It may be estimated, therefore, that such a departure from an ordinary V-shaped design of after body section as is made in passing to the shape used in cruiser stern vessels will not affect resistance more than, say, one-half of 5 percent, at the most, and even this gain is problematical. Incidentally features connected with this form of stern modify somewhat the final judgment of the matter. The cruiser shape of stern allows a wider shape of after waterline and this gives a larger moment of inertia of water plane, and, consequently, a greater metacentric height and greater stability. If the metacentric height of the ordinary shape of ship is already sufficient, advantage may be taken of the increased water plane area to reduce the breadth of the ship, and this is an incidental gain to resistance. Setting one factor against another, it may be assumed that it is not possible to improve the resistance of a ship with a really good ordinary shape of stern more than two or three percent by adopting the cruiser type. 1,100 words.—*The Engineer,* April28.

The Volatile Matter of Coal.—By J. G. O'Neill. The paper explains fully the meaning of the expression "Volatile Matter of Coal," the methods used commercially in the treatment of volatile matter, the constituents into which this treatment divides it and the properties possessed by the products obtained from volatile matter which are of special interest to the navy. By the treatment of coal commercially the volatile matter is divided into four separate products—tar, ammonia liquors, light oils and residual gas. The relative value of volatile matter as regards the calorific value of the coal may be expressed as follows: Fixed carbon or coke, 72.30 percent of total heat. Tar, 5.90 percent of total heat. Light oils, 1.60 percent of total heat. Residual gas, 20.20 percent of total heat. From this it is evident that it is quite important that coal should be so fed to boilers that all of the volatile matter is consumed. 3,500 words.—*Journal of the American Society of Naval Engineers,* February.

The Determination of the Principal Dimensions of Marine Reciprocating Propelling Machinery.—By T. S. Cockrill. A number of rules are given for the use of those engaged on the initial stages of the design of the marine machinery and for estimating. The rules are suitable for all types of vessels, usually fitted with reciprocating engines. As an example, it is assumed that the indicated horsepower and speed of the ship are given, and that it has been decided whether the proposed vessel is to have a single screw or twin screws, but that all other data remain to be fixed. The first step is to decide on the diameter of the propeller. The method is also given for finding the diameter of a wheel for a paddle steamer or stern wheeler. The other data to be obtained are boiler pressure, piston speed, mean effective pressure referred to the low pressure cylinder in multiple expansion engines, cylinder diameters, cooling surface of condensers and heating surface and grate area of boilers. 4 illustrations. 3,000 words.—*The Engineer,* April 14.

Steam Turbine Blade Fastenings.—By James A. Capstaff. In comparing the relative strengths of the turbine blade fastenings made by the Vickers-Ferranti, Brown-Boveri and the Lovekin methods, test pieces of each of these blade fastenings were made up and pulled to destruction. The results of the tests showed the Lovekin blade fastenings to be 61½ percent stronger than the Ferranti method and 56 percent stronger than the Brown-Boveri method. 12 illustrations. 1,000 words.—*Journal of the American Society of Naval Engineers,* February.

A History of Lloyds.—By J. H. Marsden. In outlining the history of Lloyds, the author describes, first, Lloyds of the Royal Exchange, the great center of marine insurance, and then takes up Lloyds Register of Shipping, which is an entirely separate and distinct corporation, working quite independent of the other. Attention is called to the very great changes which have taken place during the past eighty years and which have had to be met by the rules of Lloyds society. In 1834, ten steamers of 500 tons each were built and Great Britain owned only about fifty vessels over 1,000 tons. To-day the tonnage of the Atlantic liner may reach 45,000, and in 1913-14 forty-two vessels ranging from 10,000 to 45,000 tons were classed by Lloyds. 3,000 words.—*The Journal of the American Society of Marine Draftsmen,* April.

Shipbuilding and General Marine News

Contracts for New Ships—Marine Terminal Improvements—Recent Launchings—Improved Appliances—Personal Items

American shipbuilding led the British industry in the first quarter of this year. In the three months ended March 31, 1916, American yards launched 173 merchant vessels of 94,464 gross tons, while British yards, according to Lloyd's returns, launched 69 merchant vessels of 80,561 tons. Merchant ships now building or under contract in American yards are approximating the British output for the future. The total for American yards is 191 vessels of over 1,000 gross tons against 246 in British yards.

Only four merchant vessels were launched in Scottish yards in April, having an aggregate tonnage of 15,171 tons. The Clyde output for the last four months has been only seven merchant vessels with a total tonnage of 24,513.

Steel mills in the United States during the first week in May took orders for 30,000 tons of steel plates, bars and shapes, from shipbuilders of the Atlantic Coast, who have just accepted orders for seven more steamships to be completed during the last half of 1917. The names of the purchasers have not yet been made public, but it is stated that three of the vessels are to be built for Norwegian owners.

Shipbuilding Orders

The Williamette Iron & Steel Works and the North Western Steel Works, Portland, Ore., have received a contract from Hannevig & Johnsen, New York, for the construction of two tramp steamers, each of 8,800 tons deadweight capacity.

M. Mitchell Davis & Son, Solomons, Md., have received an order from the Baltimore & Carolina Steamship Company, Baltimore, Md., to build an oceangoing wooden steamer 200 feet long.

The Sharptown Marine Railway Company, Sharptown, Md., has received a contract from B. B. White, Baltimore, Md., to build a 1,000-ton four-masted schooner.

The Matthew Turner Shipyard, Benecia, Calif., will build three auxiliary lumber schooners 212 feet long for James Robertson.

The Francis Cobb Company, Rockland, Me., has received a contract from Crowell & Thurlow, Boston, Mass., to build a four-masted wooden schooner 200 feet long.

The Maryland Steel Company, Sparrows Point, Md., has received a contract from the Spanish-American Iron Company, Philadelphia, to build a steamship to be used in carrying ore from Cuba.

The Skinner & Eddy Company, Seattle, Wash., has received a contract from the Standard Oil Company, New York, to build two 10,000-ton oil tank steamers.

The W. F. Stone Shipyard, Oakland, Calif., has received a contract from the Hannify Lumber Company, San Francisco, Calif., to build a five-masted lumber schooner to be equipped with two auxiliary engines.

The St. Helens Shipbuilding Company, St. Helens, Ore., has received a contract from the Charles R. McCormick Company, San Francisco, Calif., for the construction of another lumber schooner.

Wilson Brothers, Astoria, Ore., have received a contract from the Charles R. McCormick Company, San Francisco, to build two auxiliary lumber schooners.

Cobb, Butler & Company, Rockland, Me., have a contract from Vane Brothers, Baltimore, Md., to build a four-masted schooner.

E. James Tull, Pocomoke City, Md., has received a contract to build a four-masted wooden schooner for Charles M. Struven & Company, Baltimore, Md.

F. H. Swails, Orange, Tex., will build a five-masted schooner for H. Praggio, Gulfport, Miss.

Shipyard Projects

The Brunswick Marine Construction Company has been incorporated for the purpose of establishing a shipbuilding plant at Brunswick, Ga. The principals in the company are George W. Hinckley, secretary and treasurer of the Apex Equipment Company, New York City; W. U. Taylor, New York City, a lawyer who has long been identified with marine interests; L. J. Nilson, Baltimore, an experienced Swedish shipbuilder, son of a shipbuilder now operating a plant in Sweden; Albert Fendig and C. G. Huggins, of Brunswick. E. L. Huggins, New York City, an experienced naval architect, will assist Mr. Nilson in operating the plant. The company will at first build wooden vessels, but it is the intention ultimately to equip for building steel steamships of all kinds. Operations will start with the construction of four 2,000-ton sailing vessels of the five-mast type, each equipped with engines of 750 horsepower for auxiliary use. These vessels are to be rushed to completion, so as to be put in service while the demand for bottoms is so great and ocean freight rates are so remunerative.

The Scottish-Mexican Oil Company, in co-operation with the Tampico Navigation Company, with which it is closely affiliated has purchased the Marvel Shipyard at Newburgh (N. Y.), where it will construct oil tankers and steel oil barges. Contracts are already in hand for several oil tank steamers of 11,000 tons deadweight capacity each and six 6,000-barrel barges. These vessels are to be built on an actual guarantee of ten percent profit above the cost of construction for the oil tankers and twelve percent for the barges. The new enterprise is known as the Tank Shipbuilding Corporation.

Control of the Tietjen & Lang Dry Dock Company, of Hoboken, N. J., has passed to a syndicate, members of which are believed to be men prominent in the Wall street district. The purchase of the property was made for the account of the syndicate by the banking firm of Bertron & Griscom and Palmer & Co. This successful property, for many years under the presidency of Frederick C. Lang, will be managed by William H. Todd, chairman of the board.

The new shipbuilding plant that is to be established near Portland, Ore., will be known as the Motor Ship Construction Company.

The Rilatt & Barrett Dry Dock Company, of Camden, N. J., has sold out to New York interests. The dock at that plant will be towed to the Philadelphia Ship Repair Company, placed in the drydock to be calked and repaired.

It is stated that plans for the formation of a company to build ten large lumber schooners are under way in Tacoma, Wash. According to report, these will all be four-masted schooners equipped with oil engines.

Captain Alexander McDougall, Duluth, Minn., announces that he is organizing the McDougall & Neath Company, to build a Welland Canal size steamer.

It is announced that work on the new buildings of the Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md., will be begun shortly. It is stated that the improvements will cost about $500,000 (£102,500).

The Seaford Marine Railway & Shipbuilding Co., Seaford, Del., has been purchased by A. D. Cummins and others. The new owners are planning to enlarge the shipyard and state that they have already received contracts to build several wooden vessels.

Pendleton Brothers, New York, have purchased the McDonald Shipyard at Mystic, Conn., and will build two four-masted schooners there.

The Pusey & Jones Company, Wilmington, Del., will build a plate and angle shop and will doubtless be in the market for machine tools.

It is stated that work on the construction of the floating drydock of the Galveston Dry Dock Company, Galveston, Tex., will begin in a few weeks. It is planned to build this dock with a lifting capacity of 5,000 tons and later to increase the capacity to 10,000 tons gross. The company plans not only to provide facilities for repairing ships of all sizes, but also to construct a shipyard in which both steel and wooden vessels may be built.

The Valk & Murdoch Company, Charleston, S. C., contemplates building a floating dry dock of about 4,000 tons' capacity and making other extensions and improvements in its shipyards.

Recent Launchings

M. M. Davis & Sons, Solomons, Md., launched on May 4 the Coast Guard cutter *Tioga,* a vessel 80 feet long, intended for the customs service in the Baltimore district.

The Standard Oil tanker *Acme,* which is 450 feet long by 56 feet beam by 32 feet depth, with a capacity of 80,000 barrels of oil, was launched at the Union Iron Works, San Francisco, Cal., on April 29.

The Munson liner *Munalbro* was launched by the Maryland Steel Company, Sparrows Point, Md., on May 6.

The tank steamer *Standard Arrow,* which is 468 feet long and has a capacity of 4,000,000 gallons, was launched by the New York Shipbuilding Company, Camden, N. J., on May 15. The vessel is building for the Standard Transportation Company.

The first of a fleet of six steel auxiliary schooners, designed by Cox & Stevens, naval architects, New York, for the Standard Oil Company, of New Jersey, was launched by the Toledo Shipbuilding Company, Toledo, on April 20. The vessel, which was christened *Starlight,* is of Welland Canal size, 261 feet long by 46 feet 6 inches beam by 23 feet 6 inches depth of hold. The vessel is rigged as a four-masted schooner and will carry as auxiliary power a 400 horsepower Bolimders heavy oil engine. This fleet of vessels will be used by the Standard Oil Company in the package freight trade on the Atlantic coast.

The turbine-driven steam yacht *Winchester,* designed by Cox & Stevens, naval architects, New York, for Mr. P. W. Rouss, of the New York Yacht Club, was launched at the Bath Iron Works, Bath, Me., on April 29. The builders' trials were held over the Government course at Rockland, Me., on May 15, where the vessel developed a speed of 31.6 knots, which is 1.6 knots above the contract speed. The yacht is 225 feet long by 21 feet beam, propelled by a twin screw arrangement of Parsons turbines, designed to deliver 7,500 shaft horsepower. Steam is supplied by two Normand oilfired watertube boilers.

The S. S. *Sucrosa,* under construction at the yards of the Fore River Shipbuilding Corporation, Quincy, Mass., for the Cuba Distilling Company, New York, was launched on May 6. The *Sucrosa* is a two-deck vessel with poop, bridge and forecastle. She is 389 feet long, 54 feet 6 inches beam and 32 feet 6 inches depth to upper deck. On a mean draft of 25 feet she will carry about 1,500,000 gallons of molasses. Propulsion is by a vertical triple expansion engine with cylinders 25, 41 and 68 inches diameter by 48 inches stroke, supplied with steam at a pressure of 190 pounds per square inch from three single-ended Scotch boilers having a total heating surface of 7,407 square feet.

Annual Convention of the American Society of Marine Draftsmen

Delegates from the various branches of the American Society of Marine Draftsmen assembled at the rooms of the Newport News Branch, in Newport News, Va., on Friday morning, April 21, and were welcomed by Honorable B. B. Semmes, mayor of Newport News; Mr. John I. Viney, president of the Newport News Chamber of Commerce, and Colonel W. S. Copeland, editor of the Newport News "Times-Herald."

Following the addresses of welcome Mr. J. E. Schmeltzer, national president of the society, was called to the chair and the business session was opened. The following delegates were present:

Branch No. 1, Delaware River, W. A. Roes and W. A. Leavitt, Jr.

Branch No. 2, Norfolk, J. B. Sadler and A. W. Chase.

Branch No. 3, Boston, C. S. Adams.

Branch No. 4, Quincy, J. O. McDonald.

Branch No. 5, Washington Navy Yard, G. W. Nusbaum and W. E. Rose.

Branch No. 6, Newport News, A. H. Haag, J. A. Kelly, S. C. Jenkins and I. H. Osborne.

Branch No. 7, Portsmouth, A. H. Frost.

Branch No. 8, Connecticut, A. C. West.

Branch No. 9, New York, P. I. Hichborn, W. H. Carter and T. S. Welch.

Branch No. 10, District of Columbia, W. S. Buckley and W. B. Newton.

Branch No. 11, Mare Island, proxy, R. M. Wagstaff, Norfolk.

Branch No. 12, Bath, R. C. Cowles.

Branch No. 13, Bridgeport, R. F. Hill.

Branch No. 14, Puget Sound, not represented.

Branch No. 15, Fore River, Government, proxy, C. S. Adams, Boston.

Branch No. 16, Charleston, S. C., not represented.

Branch No. 17, Baltimore, not represented.

After various amendments to the constitution and by-laws were proposed, the annual reports of the officers and executive committee were read and accepted. Reports were also read from the Economics, Publication, Emblem and Supplies Committees and from each of the branch societies.

At the end of the morning session, New London, Conn., was selected as the meeting place for the next annual convention.

At the Friday afternoon session the following officers were elected for the ensuing year:

President, G. W. Nusbaum, Washington Navy Yard Branch.

Vice-President, Alfred H. Haag, Newport News Branch.

Secretary, B. G. Barnes, Quincy, Mass., Branch.

Treasurer, P. K. Thurston, District of Columbia Branch.

Member of Executive Committee, H. A. Hunt, Bridgeport, Conn., Branch.

Following the election of officers action was taken on the proposed amendments to the constitution.

During the Saturday morning session charters of the Bridgeport, Puget Sound, Fore River Government, Charleston, S. C., and Baltimore Branches were ratified.

Mr. Luther D. Lovekin, chief engineer of the New York Shipbuilding Company, Camden, N. J., was elected an honorary member of the Society.

The unsatisfactory conditions in the drafting department of the New York Navy Yard led to the adoption of a resolution requesting Congressional investigation of conditions at the yard. It was also voted that the society be authorized to take up through the economics committee the question of increased pay for draftsmen in private concerns commensurate with the general improvement in economic conditions throughout the country.

At the Saturday afternoon session a resolution was passed heartily indorsing President Wilson's preparedness plan.

On Friday night the visiting delegates and members of the Newport News Branch were the guests of the Norfolk Branch at a smoker given in the Norfolk Chamber of Commerce Club. The party was brought to Norfolk on the S. S. *Virginia,* accompanied by the shipyard band, and after making a short parade through the streets of Norfolk and attending the theater and smoker, the party returned to Newport News on the steamer.

On Saturday night the annual dinner was held at the Warwick Hotel, Newport News. Mr. Saunders Van Aucken acted as toastmaster and the principal address was made by Mr. Alvah H. Martin, of Norfolk, Va., a member of the National Republican Committee. Other speakers included Mr. H. F. Gateley, Admiral F. M. Boggs, J. E. Schmeltzer, retiring president; G. W. Nusbaum, president-elect; A. H. Haag, vice-president; John I. Viney, president of the Chamber of Commerce; R. P. Adams, chief draftsman, Norfolk Navy Yard, and W. S. Copeland, editor of the *Times-Herald.*

Marine Terminal Improvements

The Public Service Commission, New York, has approved plans submitted by the New York Dock Company for the construction of large piers at the foot of Joralemon and Montague streets, Brooklyn, N. Y.

The legislature of Tennessee has been asked to authorize the City of Nashville to issue $250,000 (£61,250) in bonds for wharf terminals and connections on the Cumberland River.

The Attorney-General of Texas has approved a bond issue of $1,000,000 (£205,000) by the City of Houston for wharves and harbor improvements.

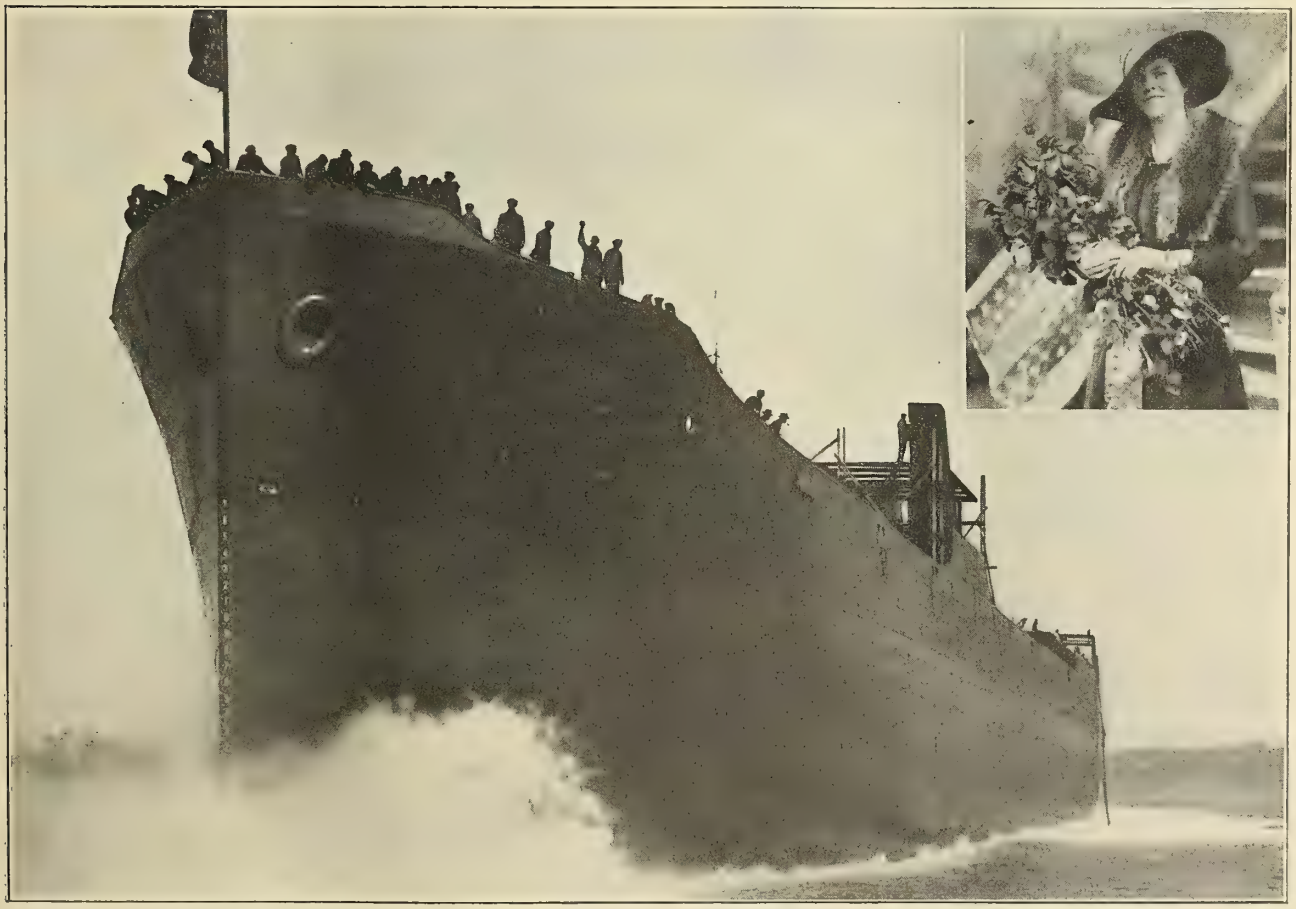
The North Vancouver Lumber Company, North Vancouver, B. C., has applied for permission to build a wharf at the foot of St. George's avenue, North Vancouver.

The City of New Haven, Conn., is planning a bond issue for the extension of the New Haven Public Wharf.

The City of Selma, Ala., will build a wharf of stone and concrete construction.

The New England Steamship Company, Boston, Mass., is planning to build a new wharf at Providence, R. I.

It is reported that five large municipal piers will soon be built along the water front in Philadelphia.



Launch of the Molasses Steamer *Sucrosa* at the Fore River Yard on May 6. Insert Shows the Vessel's Sponsor, Miss Dorothy E. Brady.

ENGINEERING SPECIALTIES

Coston Davit Turning Gear

One of the earlier disadvantages of worm and screw gearing for manipulating boat davits on board ship was that when exposed to the weather in the winter time ice and snow and other foreign matter would freeze and clog the gears. The Coston Signal Company, New York, has solved this difficulty, it is claimed, in a most satisfactory manner by fitting a housing around the gearing, impinging upon a collar cut in the main hub and allowing the housing to turn freely when the gear is working. This housing completely encloses the gearing, but allows it to be freely lubricated. It also serves the purpose of taking



Coston Gear for Turning Round Bar Davits

the thrust of the high-grade steel holding shaft which passes through the flexible eye of a standard secured to the ship's deck. The holding shaft thus prevents the housing turning when the davits and gear are working. The driving shaft connecting the powerful gearing is therefore free to work the quadruple gears in the housing and so swing the davits and boat.

Another difficulty which the Coston gear has solved is the method of allowing the gear to work freely, irrespective of the spring or bending of the davits. This is accomplished by a flexible elongated eye on the standard through which the thrust or holding shaft is placed. This eye allows the shaft to move at any angle which the davits may take. In case of an accident or the like, the gear can be readily detached. All that is required to be done is to remove the vertical pin which passes through the eye into the deck standard, and the davits are free to turn irrespective of the gearing. This is a factor of great advantage, as the gears or davits can be readily cast adrift should it be necessary to do so. Furthermore, the gearing can be uncoupled in another way if desired by the removal of a set screw which would allow the thrust shaft to be removed quickly and so release the gear.

The quadruple gears of the Coston device are so arranged that one man at each davit can readily turn in or outboard the largest lifeboat, even though the ship is listed. The gears are all cut of high-grade steel; in fact, the best thought and skill in design and workmanship have been put into this mechanism, making it efficient in every respect. The gear is comparatively light in weight and the cost of its installation on board ship is nominal. No alterations have to be made to ship's decks and no rearrangement of boats and davits is necessary.

The gear has been approved by engineers, classification societies and the United States Steamboat Inspection Service, and is being installed on a large number of ocean and coastwise vessels, including the American liners *St. Paul, St. Louis, Philadelphia* and *New York,* the Panama Pacific liners *Kroonland* and *Finland,* several of the American-Hawaiian Steamship Company's vessels, the *Crofton Hall* of the Isthmian Steamship Company, the *Ioannina* of the Greek Line, and the *Manuel Calvo* of the Spanish Line.

I. O. C. Bipolar Oxygen and Hydrogen Generator

The demand for oxygen and hydrogen for various industrial uses has grown very rapidly in the last five years. Certain lines of manufacture have been built up based on the oxygen process of welding, such as welded tanks, steel barrels, automobile parts, tubes, etc., while for repairing broken machinery, for reclaiming castings, for metal cutting of every nature, oxygen and hydrogen or oxygen and acetylene are used in steel mills, railroad shops, foundries and down to the smallest machine shop. Hydrogen likewise is in active demand; it is used more and more for cutting purposes and for light welding. This rapid development in the uses of two gases was facilitated by the introduction into this country of oxygen and hydrogen generating apparatus several years ago. Large users of one or both of these gases were thus enabled to obtain their supply direct from their own generating plant at

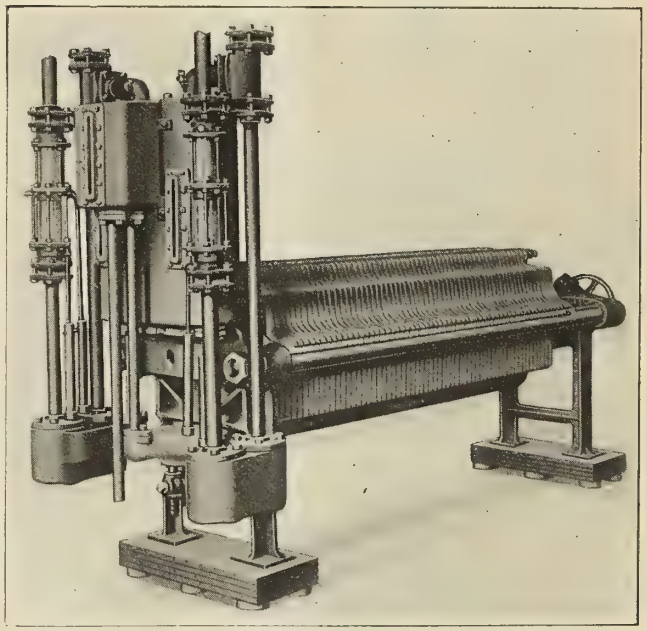


Fig. 1.—I. O. C. Bipolar Oxygen and Hydrogen Generator

low cost, in a manner suitable to their individual requirements.

In the field of oxygen and hydrogen generating equipment the International Oxygen Company, of New York, from the beginning set a standard for high-grade apparatus of workmanlike design and security of operation. The type of machine manufactured by this company known as the I. O. C. unit type is recognized as a most

efficient and high-class apparatus and is in successful operation in numerous plants throughout the country. To-day the International Oxygen Company is bringing out a new style of oxygen and hydrogen generator under the name of the I. O. C. bipolar generator. This type of

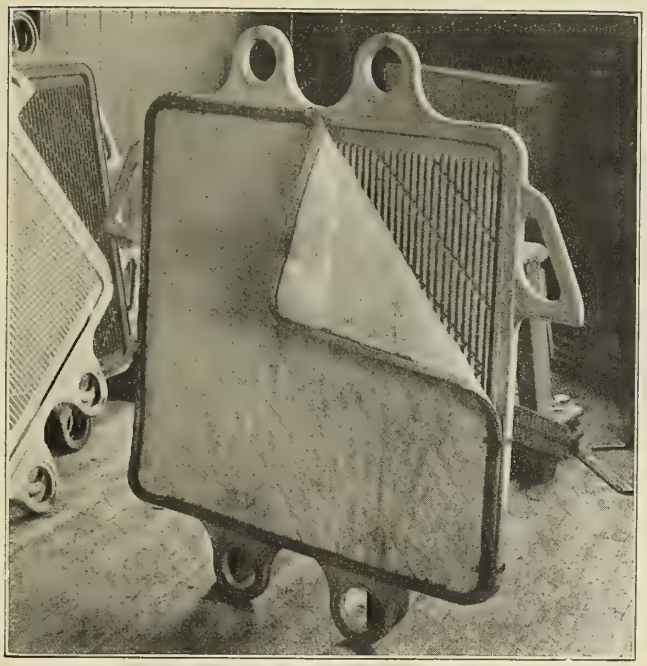


Fig. 2.—Electrode and Diaphragm

generator resembles outwardly a filter press such as used in many chemical industries. Moritz, of Wasquehal, France, patented this type of apparatus in the United States and elsewhere, and I. H. Levin, of the International

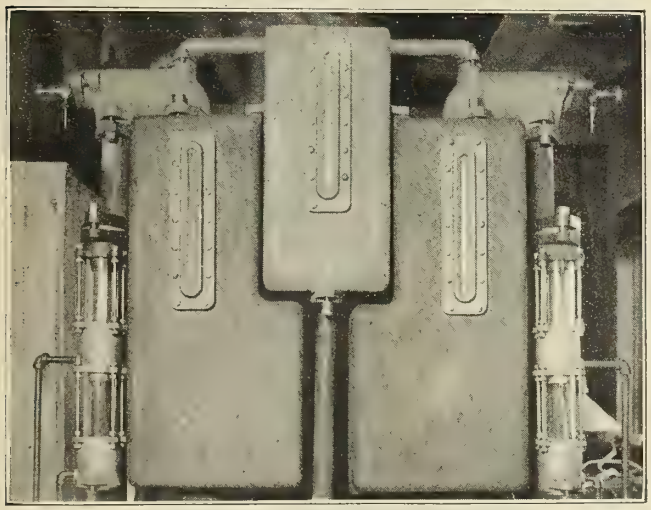


Fig. 3.—Water Tank and Gas Domes

Oxygen Company, who studied under Moritz and Flamand, perfected this machine.

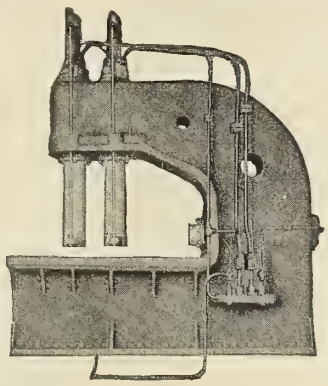
Briefly described, the I. O. C. bipolar generator consists of a series of metallic plates (electrodes) clamped up together in a heavy frame, electrically insulated from one another, and separated by diaphragms of porous fabric. Each pair of these electrodes forms a closed cell divided by the diaphragm. These cells are filled with the electrolyte (caustic potash or soda), which acts as a conductor. An electric current admitted at one end plate passes on through the plates and the solution to the other end plate. In its passage it decomposes the water in the solution into the two gases—oxygen and hydrogen—which are released on opposite sides of each plate and emerge upward into the gas off-takes. The mingling of the oxygen and hydrogen in each cell or compartment is prevented by the diaphragm, which, while permitting the passage of the fluid, resists the passage of the gases, according to a well-known physical law. As the gases are released and withdrawn the solution is automatically replenished from a supply tank. The operation is continuous so long as current and electrolyte are supplied.

The electrodes are of a special patented design, the anode side being heavily nickeled, while the cathode side is of commercially pure iron. The two gas off-takes discharge into two independent gas domes, the gas emerging below the fluid surface through an inverted "U." The pressure on both gases, clear back to the individual cells, is the same—being that determined by the hydrostatic head in the domes through the two independent risers from the water-feed manifold. This balanced pressure in both gas off-takes forbids any mixture of the gases and contributes to the balancing of pressures on the diaphragms. Both gas and water pressures are predetermined and constant.

The gases, escaping from the gas off-takes, rise through the fluid in the gas domes and pass out through discharge pipes at the top of the domes—thence downward to purgers in either side. The function of these purgers is threefold: first, to catch any entrained fluid in the gas; second, to cool the gas; third, to act as a water-check valve protecting the pressure system of the generator from any undue pressure of the gas-holders.

Southwark Standard 200-Ton Sectional Flanging Press

The Southwark standard 200-ton sectional flanging press, illustrated, which is used in boiler shops for flanging boiler heads and for other miscellaneous work, has two vertical rams of 100 tons capacity, one horizontal ram and one supplementary ram. The housing is cast of open



Southwark Flanging Press

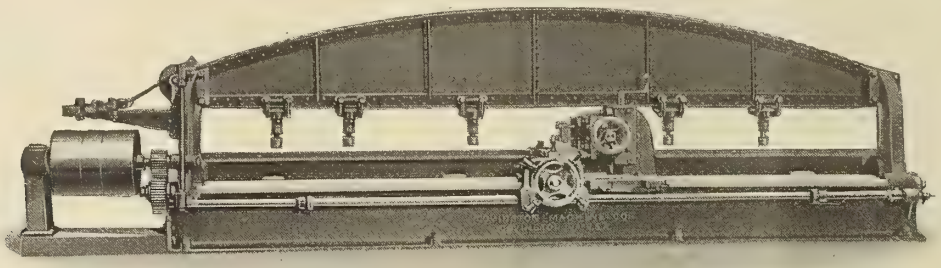
hearth steel and all of the cylinders are open hearth steel castings inserted in the housing.

The operation of the machine is accomplished by using the outer vertical ram for clamping; the inner vertical ram for flanging and the horizontal ram for squaring up the flange, or for holding the backing-up bracket, while the inner vertical ram is doing the flanging work. There is also a lower ram located between the two vertical rams, which is used for clamping and stripping.

This machine is manufactured by the Southwark Foundry and Machine Company, Philadelphia.

Covington Plate Planer

A tool of special interest to shipbuilders is the plate planer shown in the illustration, which is manufacured by the Covington Machine Company, Covington, Va. The plate planer illustrated is of small capacity with hand-operated jacks for holding the plate. Air jacks may be substituted for the screw jacks on larger machines. The planer is equipped with two tools, one for cutting in the right-hand direction or motion of the carriage and the other for cutting in the left-hand direction. In other words, it cuts going and coming, and there is consequently no loss of time. Two cuts are usually all that are necessary to straighten the edge of a plate and this may be cut square or at a bevel.



Covington Plate Planer

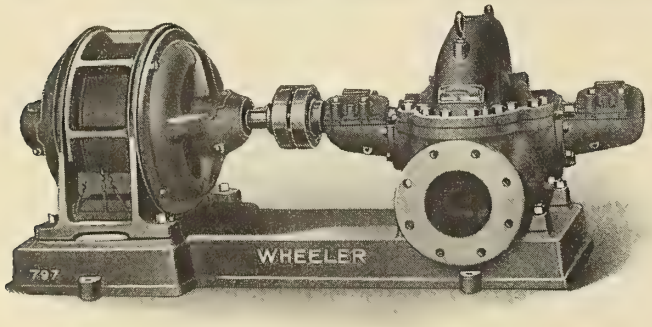
The planer bed is made of semi-steel of box construction designed for rigidity. The housings are also of semi-steel of box construction. The girder which is attached to the housing is a steel plate girder in all cases. The machines are supplied for both belt and motor drive and are designed to cut at the rate of 20 feet per minute.

Wheeler Centrifugal Pumps

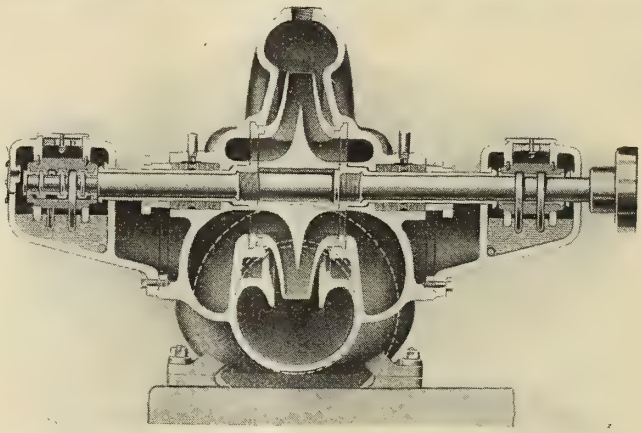
The Wheeler Condenser & Engineering Company of Carteret, N. J., is now building a line of horizontal and vertical shaft centrifugal pumps for general services as well as for condenser work. This company has been building centrifugal pumps for over twenty years, most of them being used, however, in connection with condensers. The new line of pumps is suited for all services.

A small motor-driven unit for tank or stand pipe operation is shown in Fig. 1. Referring to Fig. 2, it will be seen that this pump conforms to the most recent advances in centrifugal pump construction, having a two-part divided casing, with the suction and discharge nozzles in the lower half. The impeller is of closed double suction type, protected by labyrinth wearing rings. The shaft is protected from the water by bronze sleeves, which screw onto the shaft and extend clear through into the bearing bracket boxes. Bearings are of the ring-oiled type, and in the outboard bracket there is located a ring-oiled thrust bearing, which is a refinement not usually found in double-suction single-stage pumps. A feature of these pumps is the large size of the bearing brackets and the fact that they are bolted to the pump casing instead of being cast integral with them.

In manufacturing, particular attention is given to the casting of impellers, since the work of the designer in selecting the correct impeller dimensions may be entirely defeated by crude or careless shop work. The impellers are cast in dry sand or skin dry molds, and the cores are made from a core "sand" which is in reality a fine powder, which, when properly mixed and weathered and baked into a core, gives a surface to which the metal adheres perfectly. The result is that the finished impeller is a perfect casting, true to pattern.



Typical Small Motor-Driven Pump for Tank or Stand Pipe Service. Capacity 1,000 Gallons per Minute



Sectional View of Wheeler Centrifugal Pump, Showing Water Passages in Casing and Impeller, Also Shaft Protecting Sleeves

Japanese Line Buys Former Pacific Mail Steamers.—An example of the enormous enhancement in the value of steamships since the war brought about an unprecedented demand for vessels, was furnished recently in the announcement that the International Mercantile Marine Company had sold two of the steamships purchased by it last fall from the Pacific Mail Steamship Company. In that deal, five liners—the *Korea*, the *Siberia*, the *China*, the *Manchuria* and the *Mongolia*—were bought for $5,250,000 (£1,075,000). The *Korea* and the *Siberia* have now been sold to the Toyo Kisen Kaisha for $4,000,000 (£820,000). These vessels were acquired by the International Mercantile Marine Company from the Pacific Mail Steamship Company for the sum of $2,000,000 (£410,000).

PERSONAL

Henry J. Romely, formerly navy inspector of the Lake Torpedo Boat Company, Bridgeport, Conn., has been appointed assistant marine superintendent of that company.

Holden A. Evans, vice-president and general manager of the Baltimore Shipbuilding & Dry Docks Company, Baltimore, Md., has been made president of the company.

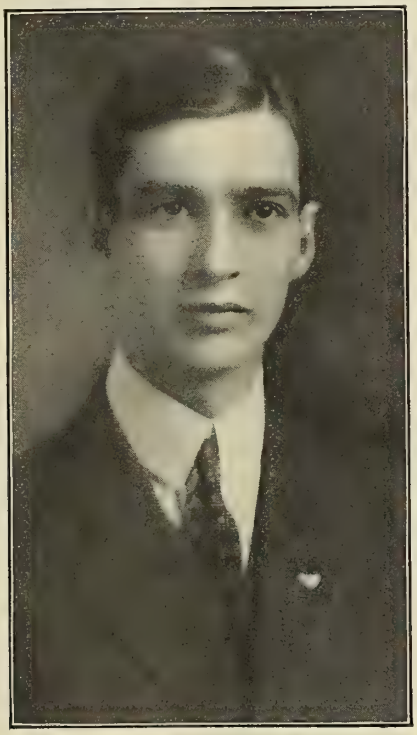
G. H. Barber, formerly chief draftsman of the Scientific Department, Hull Division, New York Navy Yard, has been appointed assistant engineer of the Interocean Submarine Engineering Company, Inc., New York.

James H. Mancor, Lloyd's principal surveyor for the United States and Canada, retired from active service on May 1. Mr. Mancor came to the United States in 1894 and was the first exclusive engineer surveyor sent by Lloyds to America. In 1905 he was appointed principal surveyor for the United States, and in 1910 his jurisdiction was extended to include Canada. Mr. Mancor is now attached to the staff of the British Consul General in New York.

James French, formerly principal surveyor of Lloyd's Register of Shipping at Glasgow, has been appointed chief surveyor for the United States and Canada, succeeding Mr. James H. Mancor, whose retirement is noted above. The vacancy at Glasgow has been filled by the appointment of James Montgomerie, formerly assistant to the chief ship surveyor at London.

OBITUARY

James C. Eckliff, vice-president of the Eckliff Automatic Boiler Circulator Company, and inventor of the boiler circulator which this company manufactures, died of typhoid fever at his home in Detroit on May 9, aged 29 years.



James C. Eckliff

Mr. Eckliff was born in Detroit on June 27, 1887, and was educated in the Detroit schools. For several years he was in the steel business, representing the Vulcan Crucible Steel Company. In 1911 the Eckliff Automatic Boiler Circulator Company was organized for the purpose of manufacturing the automatic boiler circulator and the success of this company has been attributed largely to Mr. Eckliff's efforts. The news of Mr. Eckliff's death came as a shock to his many friends, as he had been at the company's office every day up to May 5, when it was believed he was suffering from a bad cold, which eventually proved to be typhoid fever.

Albert M. Winge, member of the firm of King & Winge and one of the leading men in the development of Seattle, Wash., as a shipbuilding center, died in Seattle on April 22, aged forty-eight years.

Dan H. McInnis, chief engineer; Thomas C. Salter, first assistant; William J. Holland, second assistant, and Fred Havard, third assistant engineer of the S. S. *Roanoke,* owned and operated by C. P. Doe Company, San Francisco, Cal., which foundered off the coast of California on May 9, are reported missing, and it is presumed that they were all lost with the ship. Mr. Holland had just relieved his brother-in-law, Douglas Mitchell, former second assistant engineer of the vessel, for this one voyage while Mr. Mitchell was taking a vacation.

John Edson Sweet, founder and past president of the American Society of Mechanical Engineers, died suddenly at Syracuse, N. Y., on May 8, aged eighty-four. Throughout his life Professor Sweet held a foremost place in the mechanical engineering field. For a number of years he was a professor at Cornell University and since 1880 he has been president and general manager of the Straight Line Engine Company, Syracuse. In 1914 he was the recipient of the John Fritz medal, and during the same year he received from the Syracuse University the degree of Doctor of Engineering.

Danish Ships of 1776 Pressed Into Service.—A remarkable example of the extraordinary straits to which shipping has been reduced for want of vessels is told in a dispatch to the "Ekstrabladet" from Svendborg, Denmark. Anything that can be floated is being pressed into service. Two sailing sessels, the *Marie of Troense,* built in 1776, and the *Tvende Brodre,* built in 1786, have been rigged up and sent out to enter the competition for the enormous freight rates which are now being offered everywhere.

British Columbia to Aid Shipbuilders.—Provision for aid to the aggregate amount of $2,000,000 (£410,000) to the shipping and shipbuilding industry of the province is contained in a bill which Premier Bowser has introduced in the British Columbia Legislature. According to the *Iron Age* the bill proposes the creation of a commission which will have control of the administration of the act. Loans will be made to the amount of 55 percent of the value of the ships built under the supervision of the commission. These loans will be paid to the owner of each ship up to the number of not more than twenty ships, constructed after the coming into effect of the act, in ten annual instalments, each instalment being computed as to bring the net earnings of the ship up to 15 percent of the actual cost. The subsidy paid in any one year shall not amount to more than $5 (1/0/10) per ton deadweight capacity, the first annual payment to be made in the first year after peace is declared and thereafter annually.

It is stipulated that this subsidy shall be paid only as long as the ship remains in continuous British Columbia service; that is, carries cargoes from British Columbia and brings return cargoes to the province. Provision is also made for aid to shipbuilding plants to the extent that the commission, subject to the approval of the Lieutenant-Governor-in-Council, may advance in securities to the amount of 55 percent of the actual cost of such plant, as certified by the commission, and after the commission has assured itself that the company can furnish ample security to protect the government.

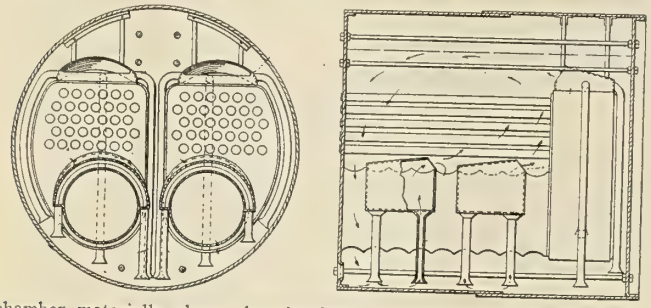
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,168,881. CIRCULATOR. F. WALTER GUIBERT, OF DETROIT, MICH.

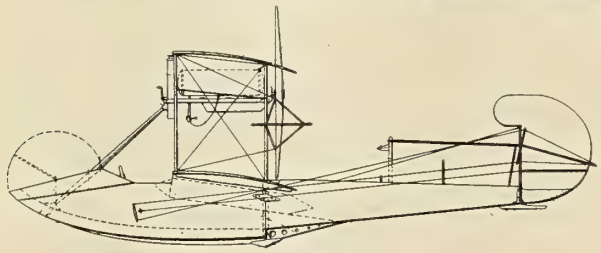
Claim 1.—In combination with a boiler provided with a furnace chamber and a combustion chamber, a circulator system comprising one or more circulators adapted to rest on the furnace and arranged to discharge in one way alone, and a circulator located on the combustion



chamber materially above the circulator or circulators on the furnace and arranged to discharge in directly opposite direction to the direction of discharge of the circulator or circulators upon the furnace. Two claims.

1,170,965. HYDRO-AEROPLANE. GLENN H. CURTISS, OF HAMMONDSPORT, N. Y., ASSIGNOR TO THE CURTISS MOTOR COMPANY, OF HAMMONDSPORT, N. Y., A CORPORATION OF NEW YORK.

Claim 1.—A hydro-aeroplane comprising a boat structure having a horizontally disposed, broad, upwardly inclined landing prow, an aerial supporting surface arranged transversely of said boat structure near the prow thereof, a base adapted to support a body of relatively large mass



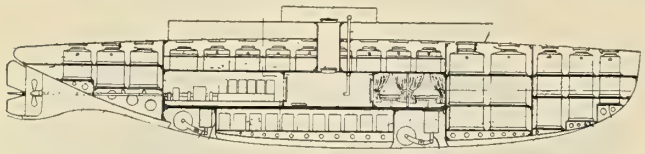
in elevated position above the body of said boat structure and in the rear of the prow thereof, a brace inter-connecting directly the front end of said base and the said prow of the boat structure, and a cockpit provided with a seat for an operator located in said boat structure below said brace. Twenty-two claims.

1,166,331. METHOD AND APPARATUS FOR SAFEGUARDING NAVIGATION. ALBERT G. DAVIS, OF SCHENECTADY, N. Y., ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

Claim 1.—The method of safeguarding navigation which consists in producing at a common point a direct indication of the difference in temperature of two different points in air or water about a ship, said two different points being so related with respect to the ship that a change in the normal difference in temperature of the air or water at these points is indicative of the presence of ice near the ship. Ten claims.

1,169,970. SUBMARINE BOAT. SIMON LAKE, OF MILFORD, CONN.

Claim 1.—A cargo-carrying submarine or submersible boat, comprising an outer hull and an inner hull, cargo-carrying tanks arranged in the



spaces formed by said outer and inner hulls, the spaces formed by said inner and outer hulls around said cargo-carrying tanks providing water-ballast compartments. Eight claims.

1,162,223. SUBMERGED EXHAUST AND BILGE-WATER-REMOVING DEVICE FOR MOTOR BOATS. GEORGE M. CRAM, OF PORTLAND, MAINE.

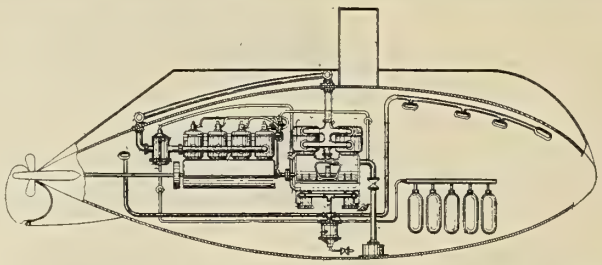
Claim 1.—In combination a boat, a casing secured to the bottom of said boat, said casing embodying in its construction a passage extending longitudinally of said boat, said passage having an outlet chamber and an inlet chamber, said inlet chamber having an inlet orifice directed toward the bow of said boat and a discharge orifice substantially smaller in diameter than said inlet orifice and communicating with said outlet chamber, said outlet chamber having a suction passage connected therewith in close proximity to said discharge orifice and constituting an exhaust passage, said outlet chamber having a second suction passage adjacent to said discharge orifice, said second passage constituting a bilge water outlet, and a valve arranged in said second passage adapted to be operated to permit or prevent the passage of fluid through said second passage. Three claims.

1,163,606. GYROSCOPICALLY CONTROLLED TORPEDO. HAROLD W. SHONNARD, OF NEW YORK, N. Y., ASSIGNOR TO CRUCIBLE STEEL COMPANY OF AMERICA, OF PITTSBURG, PA., A CORPORATION OF NEW JERSEY.

Claim 1.—In an automobile torpedo, the combination with steering mechanism, of an electric motor gyroscope for controlling such mechanism, and a single movable member for locking the gyroscope and for making and breaking an electric circuit therethrough. Thirteen claims.

1,172,992. SUBMARINE. ALLEN HOAR, OF LONG BEACH, CAL., ASSIGNOR TO ABNER R. NEFF, OF LOS ANGELES, CAL.

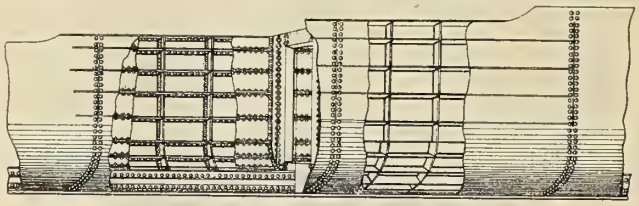
Claim 1.—In a submarine, in combination, a hull having an engine compartment, a combustion power plant in said compartment, means for



discharging overboard the products of combustion, air storage means, and means driven through the energy of the compressed air in said air storage means for operating said discharge means. Eleven claims.

1,173,432. BOAT. HENRY W. JACOBS, OF TOPEKA, KAN.

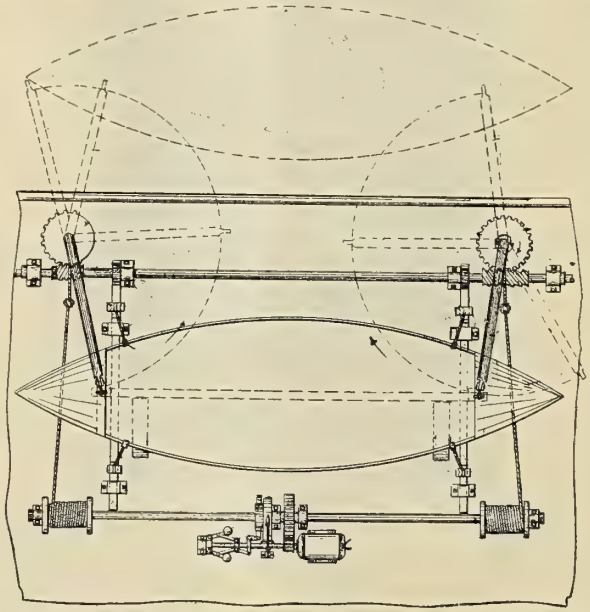
Claim 1.—A boat provided with an inner and an outer wall composed of sheet metal flanged sections, the flanges of adjacent sections being secured together with intervening stay-sheet members whereby longitudinally disposed ribs are provided and the walls maintained in proper



spaced relation to each other, some of the intervening stay-sheet members along the bottom of the boat being of greater width so as to extend to the outside of the outer wall, and flanged sections secured together and extending transversely of the boat so as to provide bulkheads. Three claims.

1,173,821. SHIP'S DAVIT. WILLIAM LUEDER, OF SAN FRANCISCO, CAL.

Claim 1.—A life boat handling apparatus comprising the combination with a support for the boat, of lashing lines and chocks for the boat, a



pair of ship's davits to which supporting cables from each end of the boat extend, a shaft extending to both of the davits, a slidable worm and a fixed worm on said shaft, a gear on each davit in mesh with said worms whereby the davits may be turned outboard, a pair of slides for holding the lashings and chocks, and a pair of pinions on the shaft for moving said bars to release the lashings and chocks. Two claims.

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American Classification Gaining Recognition

SINCE the reorganization of the American Bureau of Shipping the encouraging outlook and revived interest shown in this undertaking not only by the older yards, but also by the yards recently established in the United States, gives ample assurance that the purposes and objects of the reorganization will be fully accomplished and that American classification of merchant tonnage will become a recognized standard at home and abroad.

During the past month the Bureau has classed over 25,000 gross tons of merchant shipping and has also inspected a large amount of tonnage to ascertain the general condition for the guidance of prospective purchasers and for various other purposes. Applications for inspections, for classifications and for comparisons of scantlings of proposed construction continue to be received from both the Atlantic and Pacific Coasts and from the Great Lakes and the Gulf, and a great majority of the new construction contracted for in these districts will be built in accordance with the requirements of and under the inspection of this Bureau.

The present activity and demands for the services of the American Bureau of Shipping have never before been equaled in the history of that organization, and the feeling of confidence of underwriters, shipowners and shipbuilders alike is well expressed in the continued applications for the Bureau's services.

American Shipping's Great Opportunity

AMERICAN shipping now has an opportunity such as England had fifty years ago, according to a report on Government Aid to Merchant Shipping, just made public by the Bureau of Foreign and Domestic Commerce. This opportunity, says the report, comes at a time when American citizens owning foreign built ships can operate them under the American flag, when interest in foreign trade is widespread, the necessity for foreign markets clearly recognized and the profitableness of shipping under present conditions is alluring.

No one conversant with shipping and foreign commerce has failed to recognize the immeasurable opportunities which fate has literally thrust at the door of American shipping during the past two years. Neither has anyone conversant with the navigation laws of the United States failed to recognize the barriers which have locked the door of American shipping to opportunity. It is true that American citizens owning foreign built ships can operate them under the American flag, and that some 625,000 tons of shipping have been added to the American merchant marine in this way. Eighty-four percent of this tonnage, however, was transferred to American registry shortly after the war broke out and less than sixteen percent has been added during the past year.

If American shipping is ever to seize the opportunity that has patiently been knocking at her door, the barriers of restrictive legislation must be let down so that American built and American manned ships can compete with the world's shipping and American capital attracted to her support.

Revival of Wooden Shipbuilding

AN interesting sequel of the unusual activity in the steel shipbuilding industry in this country is shown in a most remarkable revival of wooden shipbuilding. For a long period of years subsequent to the development of steel shipbuilding in the United States and elsewhere, the business of building wooden vessels gradually declined, as the steel vessels at the prevailing prices were a more desirable investment. Some six months ago, however, shipowners and those interested in having commodities transported by water, finding it impossible to have steel ships built for them with sufficient despatch to make them available, and further realizing the enormously high cost of steel construction, began to consider the advisability of building wooden ships, and the result has been a remarkable revival of the wooden shipbuilding industry.

As the necessary equipment for building wooden vessels is exceedingly simple as compared with the establishment required for steel construction, it was evident that the location of a wooden shipyard should be governed primarily by the lumber situation, and that other things being equal, wooden ships should be built where lumber could be most cheaply procured. Accordingly, while the established yards along the Maine coast have been given a number of contracts, and are still receiving more, a number of entirely new concerns have gone into the shipbuilding business, and in the Southern States this condition is particularly marked.

As an illustration, based merely upon the reports of one firm of designers in New York, Messrs. Cox & Stevens, we find that this concern has recently placed orders for eight large sailing vessels to be built in the South, and that they expect to place orders for at least as many more vessels within a short period of time. The vessels now building include four four-masted schooners, 236 feet by 40 feet by 19 feet (two at the yards of the Wilmington Shipbuilding & Marine Construction Company and two at the yards of the Savannah Engineering & Construction Company); two four-masted schooners, 221 feet by 41 feet 6 inches by 20 feet, and two four-masted schooners, 205 feet by 39 feet by 14 feet 3 inches, at the yards of the Brunswick Marine Construction Company. All of the above vessels are to be equipped with heavy oil engines of the Diesel or semi-Diesel type, and as their construction has been most carefully considered, the vessels are given a fifteen-year highest rate by the American Bureau of Shipping, which ensures reasonable rates of insurance. These vessels will be completed within about half the

period of time required for the construction of similar steel tonnage, and for about half the first cost.

An interesting feature of wooden shipbuilding as now carried on is that the vessels are now carefully designed by competent naval architects, and are not merely built by rule of thumb and copied after some previous vessel, as was formerly the case. The naval architect has, of course, at his disposal models of successful vessels that have been built, and by combining this information with his own knowledge a material improvement in the designing and earning capacity of any vessel is certain to be secured.

Naval Preparedness—The British Fleet

BY BERNARD A. SINN

The wonderful military efficiency of the Teutonic armies has been the study of all military and naval experts the world over. England, as far as possible, is applying her analysis of the German army organization to the development of her navy, and from the experience gained, since the beginning of the war, has finally decided on an offensive fleet formation, a fleet of high speed, vast offensive strength, complete within itself, and mobile to a degree hitherto unthought of.

The general tactical units of fleet, division and squadron are still undisturbed, but the assignment of vessels to these units is different from anything attempted before.

The offensive fleet consists of two divisions of three squadrons each. Every division is composed of two squadrons of battleships and one squadron of battle cruisers, a total of six fighting units of four vessels each, or sixteen battleships and eight battle cruisers.

Each squadron of battle cruisers has attached to it the scout cruisers of the division, one for each battleship in the division. The scout cruisers now building or recently completed for Great Britain are large, high speed vessels of over 30 knots sea speed, and capable of long voyages. In addition to the eight scout cruisers attached to each battle cruiser squadron a new type of destroyer has been built, and eight of these are attached to the battle cruiser squadron. These scout destroyers are of 1,800 tons displacement and about 35 knots sea speed.

The battle cruiser, or fast mobile, part of each division consists of four battle cruisers, eight scout cruisers and eight scout destroyers, all basing on the battle cruisers, all of 30 knots speed and of the greatest mobile effectiveness. To each battle cruiser there are also attached repair ships, ordnance and store ships and eight fuel ships. The auxiliaries have equal speed to the capital ships and are able to accompany this mobile squadron, and form part of a complete and harmonious unit of the highest speed.

The main, or fighting, squadrons are composed of battleships, destroyers and submarines. A division consists of two squadrons of four battleships each. These vessels are of the largest and most powerful type afloat, the latest being designed for 24 knots sea speed. To each squadron of four battleships there are assigned sixteen destroyers and sixteen fleet submarines. The destroyers are boats of from 1,000 to 1,250 tons displacement and 28 to 30 knots speed, and the submarines are of the largest types, the latest being over 20 knots speed and able to maneuver with the fleet.

The fighting vessels of the fleet are as follows:

Eight battle cruisers, 12 battleships, 16 scout cruisers, 16 scout destroyers, 32 fleet destroyers, 32 submarines.

In order to make such a fleet still more effective, particular stress has been paid to the auxiliary vessels, and over 100 vessels of different types have been assigned to the fleet. Each division has one hospital ship, one submarine repair ship, one ship for machinery and electrical repairs and one general repair vessel. For each squadron there are provided one food supply ship, one refrigerator ship, two ammunition ships, eight colliers and four high-speed seagoing towboats. The latter are used to handle disabled boats, to assist the slower vessels, when necessary, to act as dispatch boats, and as fire and wrecking boats, for which purpose they are especially fitted with large pumps and derricks.

A complete fleet will have as auxiliaries the following:

Two hospital ships, 10 repair ships, 10 supply ships, 10 ammunition ships, 48 fuel ships, 16 towboats or dispatch boats. A total of 96 vessels of all kinds.

To man this enormous fleet requires 80 officers and 1,200 men for each capital ship, each scout takes 32 officers and 400 men, each destroyer 5 officers and 130 men, each submarine 3 officers and 20 men. The auxiliaries, in addition to their regular complements, carry a large reserve of both officers and men, in order to keep the fighting ships fully supplied with full crews. The foregoing clearly indicates the huge number of men required for a fleet in war times, a total of over 4,000 officers and 50,000 men.

The early months of this present war demonstrated that the officers and men on small craft, such as submarines and destroyers, are constantly breaking down under the severe mental and physical strain to which they were subjected. In order to avoid this as much as possible, the officers and men are supplied from the capital ships of their respective squadrons and 48 hours is now the limit of service on the small boats. Daily changes are made when practicable, and in this way officers are only required to do duty on the smaller ships on the average of one day in six. Constant shifts are also made from the capital ships to the auxiliaries and vice versa, so that the high tension under which both officers and men are working may be relieved as much as possible. As the drills on large ships are continuous, a week on a collier would seem like a vacation to the tired officers and men.

Let us glance at the formation of this tremendous fleet. The sixteen scout destroyers, using the scout boats as a base would advance from 25 to 30 miles ahead of the scouts with a distance of 5 to 10 miles between each vessel, thus effectively covering 200 to 300 miles and converging on a battle cruiser as a base. The battle cruisers are at a distance of 10 to 20 miles from the support to the scouts. From 10 to 15 miles in the rear of the battle cruisers would be the battleships in squadron formation, ready to support the battle cruisers, and flanked by the destroyers and supported by the submarines. At the approach of an enemy, the advance scouts would retire to the rear, the battle cruisers would form the first attack until the battleships arrive, when they would form the rear guard ready to dash out to the support of any weak unit, or to pursue an escaping enemy's ship, or to attempt a flank maneuver. Meanwhile the torpedo boats and submarines would act as the commander of each battle squadron directs, either to make a heavy pall of smoke to disguise fleet maneuvers, or as a screen for submarine operations. At the same time the battle cruisers, with their tremendous speed, may attempt to gain the rear of the attacking ships, cutting off their retreat and taking up a raking position and still further embarrassing the enemy.

Even a casual glance at this tremendous fleet organization shows that an attacking force would have no chance unless it were of equal numerical strength, equal speed and effectiveness. The mobility, power and

strength of this fleet can hardly be estimated, with its 50,000 men, 4,000 officers, 360 to 400 guns of the heaviest caliber, homogeneity in every detail, self-contained and self-sustaining, and the inevitable sea battle, which must come sooner or later, will show the wisdom of such an organization.

Great Britain has three such fleets prepared and a fourth under construction and with the present rapidity of work in the dockyards and private plants, is able to completely equip and construct a fleet such as is herein described in fourteen months.

How futile our own efforts in the direction of naval preparedness seem when compared to those of other nations! Each of Great Britain's great offensive fleets contains more fighting ships, more auxiliaries, more officers and more men than the entire naval establishment of the United States. We have at present in commission only five ships of the first class, and in a battle fleet sixteen are required. All other battlships in commission in our navy are only good for coast defense or training purposes. We have no battle cruisers, we have no scout cruisers, we have no large scout destroyers, no large submarines. In other words, as an offensive fleet the United States has one battle squadron with the necessary destroyers and nothing else. As for officers and men, probably two squadrons could be effectively manned and enough auxiliaries be gathered together sufficient for one squadron. All the warnings of our General Board have gone unheeded for years. Although nearly $700,000,000 (£143,740,000) have been spent on our naval establishment in the last five years, we are unable to supply the necessary vessels for a division, let alone a fleet.

When will the people of this great country learn the lessons that are being taught daily in Europe, and when will useless political waste give way to proper economical preparedness?

[Note: The information herein contained, while derived from trustworthy sources, is not official.]

Shipbuilding on the Columbia River

With a shipyard at St. Helen, Ore., just below the city of Portland, engaged in the construction of two vessels of the type of the *City of Portland,* launched recently and described in our last issue, with work proceeding on construction of four steel ships at the yards of the Willamette Iron Works and the Northwest Steel Company, with a dredger at work at the docks of the Peninsula Lumber Company, preparing for the establishment of a shipyard by F. C. Knapp, with the Motorship Construction Company incorporated and pushing plans for a ship construction plant at Vancouver, Wash., across the Columbia River from Portland, and with two vessels under way at Astoria, near the mouth of the Columbia River, Portland and the Columbia River basin are entering on an era of shipbuilding that will restore a large number of wooden vessels to the commerce of the seas.

At St. Helen the John R. McCormick Company is operating and has turned out a vessel that seems to be accepted as a pioneer of a new order. The type is being adopted by most of the other yards and is a combination of sail and auxiliary power which gives a larger offshore radius of action and safeguards against the delays that were formerly experienced by sailing craft.

In all sections of the West it is believed that the wooden ship is coming back and that if the era shall be short-lived as compared with former days it will be of sufficient duration to warrant the investment in the business at this time. Many financiers are of the opinion that because of the cheap construction and the tremendous forests that are available on the Columbia River the wood bottoms will never again go out.

Using the *City of Portland,* recently launched, as the type of vessel which all the yards are endeavoring to duplicate, a description would be as follows:

Single decker; length, 278 feet; beam, 48 feet; depth, 19.6 feet; gross tonnage, 1,750; net tonnage, 1,671; lumber capacity, 2,000,000 feet.

Her power consists of a 7,000 square yard spread of sail and a pair of semi-Diesel engines, each unit developing 320 horsepower. The fuel is "caloil," a product of the California oil fields which costs $1 (4/2) per barrel. The estimated cost of operating both engines for twenty-four hours will be $20 (4/3/4), or 20 barrels. A speed of 8 knots is expected when running without sails or in a dead calm. The two methods may be combined and the speed greatly enhanced. The plan of the operators is to use sail exclusively when winds are sufficiently strong, so that the cost of operation may be reduced to a minimum.

In the construction of the *City of Portland,* 1,200,000 feet of Oregon fir was used. The cost is divided as follows:

Labor	$40,000
Lumber	30,000
Iron and spikes	15,000
Oakum, rigging, supplies, etc.	15,000
Engines and installation	50,000
	$150,000 (£30,700)

Shipbuilders at Portland estimate that a steel vessel of similar size and power would cost $35,000 (£71,750) at this time of high prices, while under normal prices it would cost $250,000 (£51,250).

While operating costs are problematical, careful estimates of costs by the owners indicate that a vessel of class of the *City of Portland* may be operated for $3,500 (£718) per month. This includes $1,200 (£246) as wages, $750 (£154) for insurance at 6 percent, and $600 (£123) for fuel. Experienced operators are of the opinion that the engines need be kept running not more than one-fourth of the time, and that the cost of fuel may be reduced to a maximum of $150 (£31) per month. Interest is figured at $870 (£178) per month, while upkeep will not be higher than on wood vessels of ordinary type. Depreciation is problematical, as the semi-Diesel engine has not been long enough in use to establish a record of facts.

The *City of Portland* went into commission this month, and has already been chartered for three trips to Australia. She will earn enough on those voyages to pay for herself.

If the new era shall be permanently established, it is probable that the Columbia River will witness a very rapid development of the shipbuilding industry because of the close proximity of enormous quantities of suitable timber. It is conservatively estimated that 200,000,000 feet of such timber can be secured from the Columbia and its tributaries and floated to the yards. Sticks of 150 feet in length are not rare, but, on the contrary, are very ordinary pieces of timber in these forests. Certain it is that in no other part of the world can as many advantages of material and water frontage be had as along the Columbia.

Steel Ships Under Construction

Material is now arriving at Portland for the construction of the steel ships referred to above. They are to be 429 feet long over all, 54 feet beam, 29 feet molded depth, and are to have an average speed of 11½ knots. They are to cost $1,000,000 (£205,000) each and are for Norwegian owners. All are to be used as tramp freighters.

Economic Marine Propulsion

BY THOMAS J. ROGERS

The purpose of this article is to ascertain the relations which, in steamship propulsion, exist between the speed of the ship and the fuel which must be consumed to obtain that speed; and also to find the most econmoical rate at which that vessel can proceed.

It must be conceded that the most obvious and the most conclusive method is to try the ship at all desirable speeds; but the expense in time, labor and money is prohibitive; therefore a satisfactory method for calculating these matters, in these days of large ships and large coal bills, has become a necessity.

Ordinarily speaking, the power required to propel a ship at any speed varies with the cube of that speed, and, incidentally, with the cube of the revolutions of the propeller which produces the speed. But the ratio between the speed of the ship and the revolutions of the propeller varies greatly with the weather; thus with a very strong head wind the revolutions may be great and the speed almost nothing. For this, and for many other reasons, the revolutions, rather than the speed, will be used as a basis for calculation.

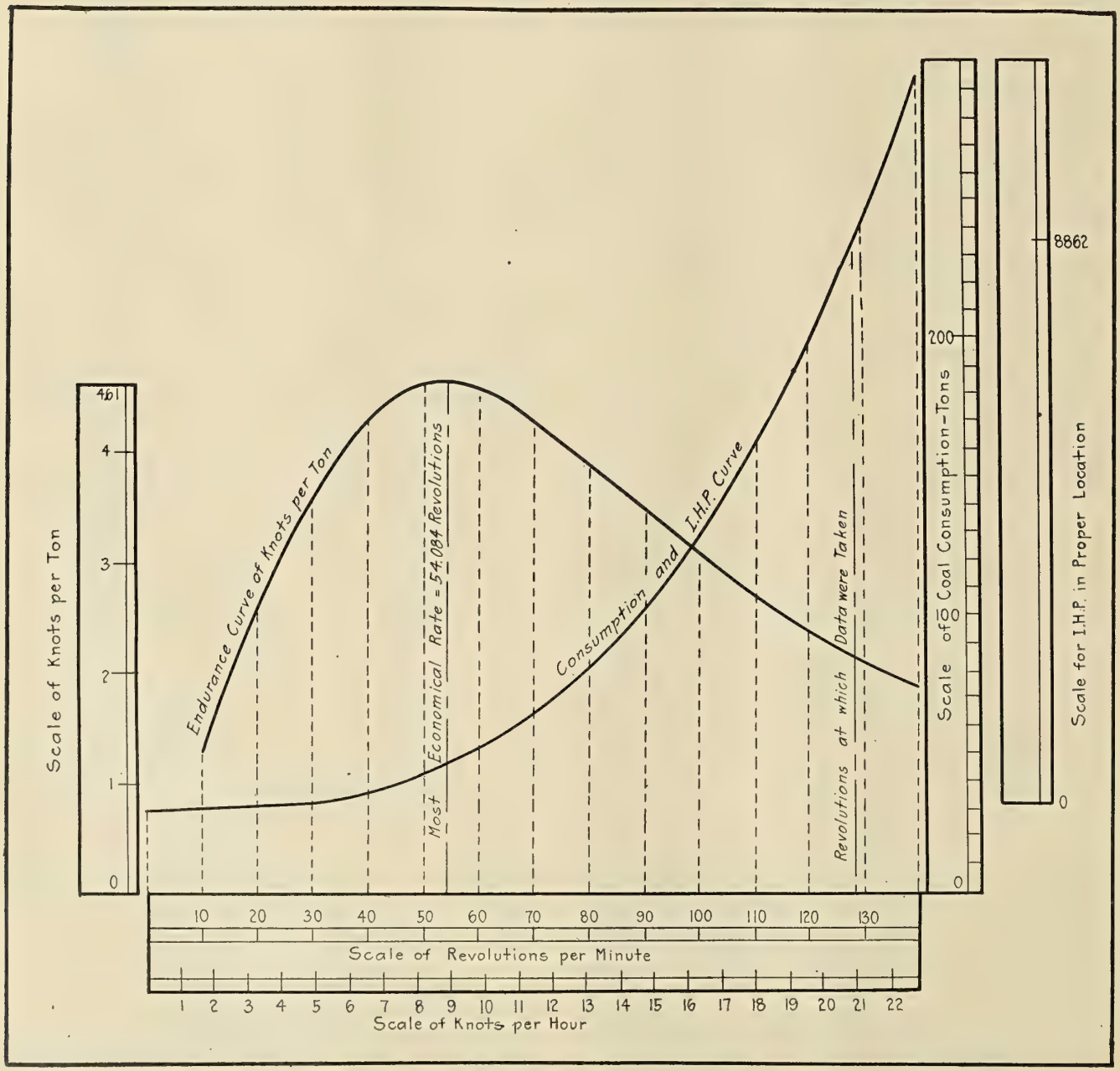
There are two standpoints from which to study this question:

First. A vessel, as for instance a vessel of war, having a certain amount of coal on board, may desire economic propulsion, in order to make her coal carry her as far as possible. She would therefore proceed at such a rate as to make each knot cost as little as possible in coal or, in other words, she would seek economy in fuel.

Second. A merchantman, however, would seek economy of a commercial kind. She would, therefore, proceed at such a rate as to make each knot cost as little as possible in money; or, in other words, she would seek economy in money.

Consider economy in fuel first.

It is easy to understand, whether a vessel proceeds fast or slow, or even if stopped altogether, that a certain quantity of coal must be consumed to supply auxiliary power and to maintain the temperatures of boilers, pipes,



Performance Curves of Large Ocean-Going Liner

cylinders and other hot surfaces, and that this quantity is not a variable, but is a constant quantity, amounting to q tons per 24 hours. To this must be added the real cost of propulsion, which, at the rate of one revolution per minute, amounts to k tons, and at the rate of R revolutions, to $k R^3$ tons per 24 hours.

Within this time unit, therefore, the total quantity consumed will be:

$$Q = (q + k R^3) \qquad (1)$$

At the rate, therefore, of R revolutions, the cost per day of each revolution is

$$\frac{Q}{R} = U = \frac{q + k R^3}{R} \qquad (2)$$

If now

$$\frac{d U}{d R} = \frac{3 k R^3 - q - k R^3}{R^2}$$

be placed $= O$.

then

$$R = \left(\frac{q}{2 k}\right)^{1/3} \qquad (3)$$

and is the most economical rate possible

To obtain the constants q and k it is necessary to try the ship at two different rates, viz., at R and at R_1 revolutions from which is derived $Q = (q + k R^3)$ and $Q_1 = (q + k R^3_1)$ and therefore

$$k = \left(\frac{Q - Q_1}{R^3 - R^3_1}\right) \text{ and } q = (Q - k R^3) \qquad (4)$$

By the above method, therefore, three most useful equations are obtained.

By (1) a curve is plotted showing coal consumption at all possible speeds.

By (2) a curve of endurance is plotted for all possible speeds.

By (3) the economic speed is found direct.

To apply the above method to merchantmen, it is only necessary in these equations to substitute for the coal in tons its value in money, and to add to the constant q other constant expenses in money, such as keep of passengers, interest, insurance and so forth. Since in the case of merchantmen q must be increased, a curious corrollary arises, viz., the economic speed of a merchantman is greater than that of a man-of-war.

What has thus far been written is substantially the original method, which may be called the rigid method, to distinguish it from what follows, which may be called the provisional method.

Experience demonstrates that under the circumstances usually attending the trials of new ships it is well nigh impossible to obtain correct data for more than one rate of speed. Nevertheless it is highly important to have some idea of what the future performance of that ship will be. To meet this difficulty the following method of finding the values of q and k from one trial only has been devised. It is based upon the fact that since there is a constant quantity of q tons consumed, even though the ship is stopped, therefore the power unit, within the time unit, costs m times more at the lower than at the higher speeds.

Let R = revolutions at which data are taken.
R_1 = revolutions at the economic rate.
$Q = a \times (\text{I. H. P.})_1$ = total coal per day at R revolutions.
$Q_1 = ma \times (\text{I. H. P.})_1$ = total coal per day at R_1 revolutions.

Let also $(I.\ H.\ P.) = b R^3_1$.

Then

$$a = \left(\frac{q + k R^3}{b R^3}\right), ab = \left(\frac{q + k R^3}{R^3}\right)$$

and similarly

$$m a b = \left(\frac{q + k R^3_1}{R^3_1}\right)$$

But by equation (3)

$$R^3_1 = \frac{q}{2 k}; \text{ therefore } mab = 3 k \qquad (5)$$

Into (5) restoring the values

$$a = \frac{Q}{\text{I. H. P.}} \text{ and } b = \frac{\text{I. H. P.}}{R^3}$$

Then

$$k = \frac{m Q}{3 R^3} \text{ and } q = Q - k R^3. \qquad (6)$$

Now all of the above values are to be found in the data of one trial, except the value of m, which must be assumed; and because this method depends on an assumption, therefore it is called provisional.

But this value may be derived from trials with other ships, and the results obtained by this method are more accurate than when taken from data in the least degree doubtful; in proof of which are given in the illustration herewith the performance curves of a large ocean liner, calculated from the value of m found from data taken from only a fair size coastwise vessel, than which two more dissimilar vessels could scarcely be imagined.

The American Merchant Marine

BY FRANK J. NOLAN

Restoration of the American merchant marine is not the concern of any one political party, nor of any particular interest or set of individuals, nor of any one section of our country; it is a national issue of the most vital importance to every man, woman and child in the United States to-day.

No nation has ever become truly great or become an important factor in international affairs or foreign commerce unless it has been great on the seas. There is no question in my mind but that the United States cannot hope to reach its full growth and measure of progress until its shipping and commerce are relatively equal to its industries on land. Soon after its birth our nation was in dire distress. Foreign ships had flooded the country with foreign manufactures of all kinds. The products exported from this country were not sufficient to pay for our imports. The country was swept of its specie and the national debt had begun to grow. Skilled labor could find no employment and want and misery prevailed. The very independence of the new republic seemed to mock the people who now faced famine with all its ravages and horror.

But our first Congress, meeting in the year 1789, changed things immediately. The first boost given to the merchant marine of America was administered by Congress when it passed a tariff act which Washington signed on July 4, 1789. This act contained the first declaration of maritime independence. This law provided a ten per cent reduction in duty on imports in American vessels and was so arranged as greatly to favor American ships in the carriage of tea from the different ports of the Orient. It goes without saying that the adoption of this tariff tremendously stimulated home production. The diversification of industries soon afforded profitable employment for everybody. Our specie returned, manufactures flourished, shipbuilding grew by leaps and bounds, prosperity was restored and the well-being of the new republic once more was assured.

Previous to the adoption of our first tariff but 23.8

percent of the imports and exports of the United States was carried in American ships. A few years later, under the new law, American ships were carrying 90 percent. The loss of revenue caused by the discount of 10 percent in the duty on imports in American ships actually embarrassed the government. The act therefore was amended, and instead of a reduction of duty in favor of American ships an increase of 10 percent was imposed on all imports in foreign ships. Following this action for a period of about thirty-five or forty years, American ships carried on an average of nearly 90 percent of the foreign commerce of the United States. In 1826 they carried as much as 92.5 percent. This, as far as I can ascertain, was the largest proportion ever borne under the American flag in any one year. Who of our forefathers at that time even dreamt that we would to-day be in such a humiliating position as we are in regard to our merchant marine?

Foreign Commerce Carried in American Ships

For the information of those not conversant with the merchant marine of their country, I give the following table showing the commerce carried on American ships from the year 1789 to the year 1914. These figures, as anyone can see, are not anything to be in any way proud of:

	Percent		Percent
1789	23.8	1860	66.2
1795	90.0	1870	35.6
1800	89.0	1880	17.4
1810	91.5	1890	12.9
1820	89.5	1900	9.3
1830	89.9	1910	8.8
1840	82.9	1914	9.7
1850	72.5		

These figures speak for themselves and show without a doubt the appalling state of our merchant marine to-day in comparison with former years. When one considers that about seventy years ago American ships carried nearly 90 percent of the commerce of the country and to-day are carrying less than 10 percent, one has to stop and think what has happened to the merchant marine of America to-day.

It is a most remarkable thing that while our imports and exports have grown to immense proportions, our merchant marine has dwindled to an almost negligible figure. From $71,670,735 (£14,700,000) in 1830, exports have increased to $2,364,579,184 (£485,000,000) in 1914, and imports for the same number of years have increased from $62,360,956 (£12,800,000) to $1,893,925,657 (£388,000,000). The United States to-day produces 50 percent more than she can consume and it is only natural that we must and ought to have an outlet for our overflow of produce. It is very true we have an outlet for our products, but at what an awful cost to our producers and manufacturers!

How do we transport our products and get them on the foreign markets of the world? How do we compete with foreign countries who have vast merchant marines three times the size of ours? Under the present conditions we have to go to foreign shippers and ask them to transport our products to foreign markets for us, as we haven't got a merchant marine to do it with. Is it not a disgrace and a shame that a great country like the United States to-day has to humble herself and go and ask a foreign nation to carry her goods for her so that we may in a way get our products on the foreign markets and thereby compete in the world's commerce?

We not only have to get a foreign shipper to take our products over the ocean for us, but naturally we have to pay *his* price, whatever the prevailing freight rates may happen to be at that particular time. His freight rates are by no means low, and we thereby have to stand for a severe cut into our profits, which in plain words is making a millionaire out of the foreign shipper at our expense. At the present time we haven't a single ship that can compare favorably with the giant *Mauretania, Olympic, Aquitania,* or *Vaterland,* whose tonnage varies from 40,000 to 50,000 each.

For five months in the year American tourists pour in a steady stream into Europe, going and coming back on foreign ships because there are no other ships to take them, at least no American ships flying the American flag. In this one instance alone are not millions of American dollars flowing into the pockets of foreign shipping companies which, if we had a fleet of American-owned and American-built ships, could be diverted into the pockets of American shipowners and thereby keep the vast millions of dollars now going out of the country in the country? I haven't the slightest doubt but that if the American public were to educate themselves in matters pertaining to the merchant marine of the country they would open their eyes to the fact that we are in a sorry plight for a country of our size. There are millions of people in this country who do not know anything of or have never seen the merchant marine of this country, and who, until the matter has been laid before them in a plain and unvarnished way, cannot be expected to know much about the thing that is the very life's blood of every maritime nation—namely, its merchant marine.

Our overseas shipments during the twenty-year period ending 1895 amounted to something like $28,000,000,000 (£5,750,000,000). Of this total American ships carried 17 percent and foreign ships 83 percent. Ocean freights in normal times average about 6 percent of the value of the goods shipped; but at the present time the prevailing rates are away above this mark, and much to our regret American shippers are only getting a very small share of what they ought to be getting. In 1914 the rates rose to 13.6 percent, but on a basis of only 6 percent it cost the United States over $1,500,000,000 to have its freight transported so that we could get in on the foreign markets. This figure is for the last twenty years. Of this amount the United States earned only $285,000,000 (£58,500,000), while foreign ships earned something like $1,500,000,000. This is another flaring example of our lack of a merchant marine.

Earnings of American and Foreign Ships

Our total overseas commerce for the twenty years just ended amounted to nearly $50,000,000,000, which is an increase of 78.3 percent over the previous twenty years. In the carrying of this commerce American ships earned something less than $300,000,000 (£61,600,000) and foreign ships more than $2,500,000,000. Should America stand still for the next twenty years as regards her merchant marine, it is not very hard to see what the result would be to America at the end of that time.

The average life of a ship is twenty years, and according to Lloyd's reports the present world's tonnage of ships (in excess of 100 tons) is 49,089,552. Under normal conditions $500,000 (£102,500) will build a 5,000 ton ship. On this basis we have bought and paid for during the past twenty years, in freight charges alone, the equivalent of 26,965,692 tons, or more than half the world's tonnage to-day, and we stand ready during the coming twenty years, unless we wake up from the present lethargy, to replace this worn-out tonnage with new ships equal on this basis to 48,088,589 tons, all a gift to foreign nations. History proves that no country not endowed with maritime power and ability has ever risen to first importance. History has also proved that no nation can hope to reach the pinnacle of commercial importance and success unless it controls the transportation of its exports from the pro-

ducer to the customer and the banking, exchange and insurance transactions which accompany that commerce.

There is close affinity between land industries and overseas commerce. The development of the latter has direct bearing upon the employment of both labor and capital, and where a nation has no ships that development becomes correspondingly difficult. Irregularity of employment is a curse to which poverty and discontent are the sequel. With us in America it is either a feast or a famine. Employment of capital goes hand in hand with employment of labor, and continuous employment for both is essential to our industrial welfare and progress. Demand regulates activity in all manufacturing institutions. When demand is less than capacity, factories must either run on short hours or else close down entirely from time to time, and when this condition obtains both labor and capital suffer, the cost of the factory production increases and there is corresponding decrease in our ability to compete with foreign nations for the world's trade.

Foreign Markets a Necessity

In many lines of manufacture production outstrips consumption, and notwithstanding the tremendous absorptive powers of the United States our manufacturers in many lines are to-day face to face with this condition of output exceeding demand. Since our home markets are inadequate, we must, perforce, find foreign markets which will take our surplus goods from us in order that the development of our industries may flow along uninterruptedly and both labor and capital find continuous and profitable employment.

At the present time we export about 5 percent, or one-twentieth, of our manufactured goods, whereas in normal times England and Germany export respectively 55 and 45 percent. I should estimate that the commercial census will show for this year that this yearly production has grown to the enormous total of $25,000,000,000 (£5,125,000,000). If we should develop our foreign trade possibilities to the fullest extent, which I know is possible only by possessing an adequate American merchant marine, the percentage of our exports of manufactured goods would greatly and naturally increase. It does not require a great stretch of imagination to picture the prosperity which would spread its mantle of contentment and happiness over the whole length and breadth of the United States if this 5 percent were even increased to 20 percent, to say nothing of what England and Germany are doing in normal times with their 45 and 55 percent.

In the exportation of American foodstuffs, competition does not figure, for foreign nations are simply buying from us the things that they themselves cannot grow in sufficient quantities for their needs, but this is not true of manufactured goods. In the marketing of these we find ourselves in direct competition with other manufacturing nations of the world's keen and sometimes unscrupulous competition. In the absence of American ships to carry our goods this is competition which we cannot hope to meet.

What Constitutes a Merchant Marine?

Let us consider what really constitutes a country's merchant marine. It is unfortunate, but a very true fact, that most of our people, whose ideas represent public opinion, visualize great Atlantic liners when they think of the merchant marine. These huge liners are most in evidence to the traveling public who happen to visit our large eastern seaports, and their size and magnificence appeal to the eye and mind in a most emotional way.

In Great Britain, for instance, it is not due alone to this class that she stands unrivaled in the world's cargo carrying. It is to the tremendous number of first class tramps, with their enormous cargo capacity that she owes her preponderance over every other nation. It is merely wasting time to attempt to solve the problem by acquiring a few steamers to run on regular routes and with fixed schedules. Ships of the tramp type are the prime necessity in international trade. If a poor harvest in South America cuts off grain export, then the tramp that has worked in the South Atlantic Ocean seeks freight at the mouth of the Danube or in South Russia, or in the Indian Ocean, or the East Indies. Wherever freight is offered there she may go—to Rangoon for rice, to Calcutta for jute, or to Java for sugar. It would be absurd to engage in international trade with such ships and confine their operations to the carriage of our own exports and imports alone, for, as those conversant with shipping in America to-day can easily see that they would be roaming over the seas in ballast for six months out of twelve, while their competitors, roaming over the world usually with full cargoes and consequently greater earning power, would be able to underbid American ships in rate quotations on American cargoes whenever such cargoes were offered.

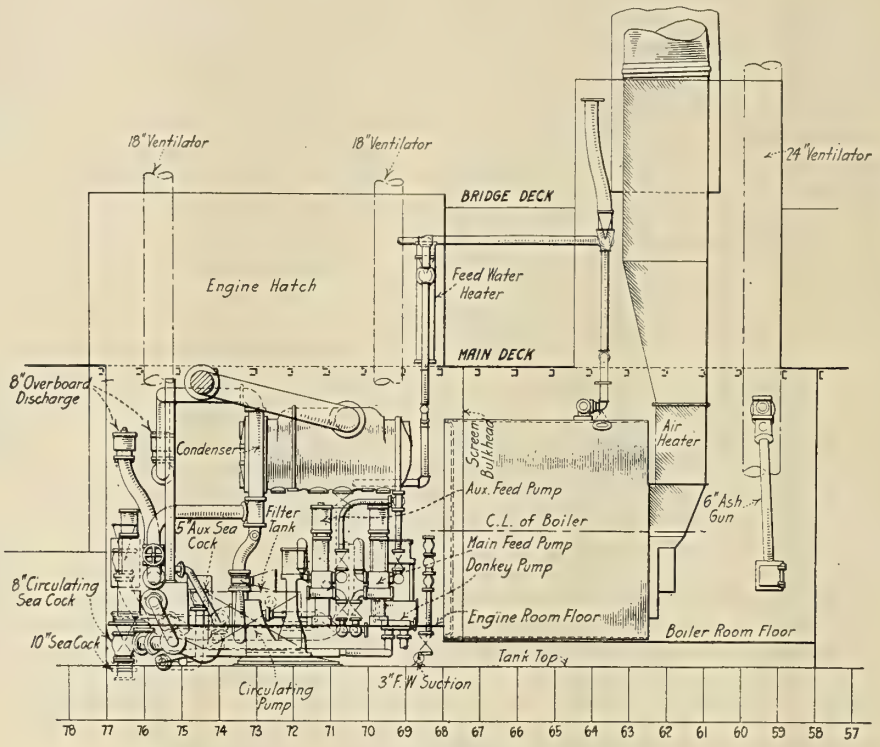
If conditions brought about a war between America and one of those nations who now carry most of our products to foreign markets, the first thing that those nations would do would be to withdraw all their merchant ships from this side of the Atlantic, leaving America with no means of transporting her overflow of products overseas. The small merchant marine we now have would be taken over by the government for war purposes, supplying the fleet, transporting troops and so on, thus bringing the commerce of the country to a standstill as far as foreign countries are concerned. This, most Americans must admit, is a deplorable state of affairs to have to look forward to in case of trouble at any time with the nations that we are now beholden to, to get our products on the markets of the world.

Germany's Example

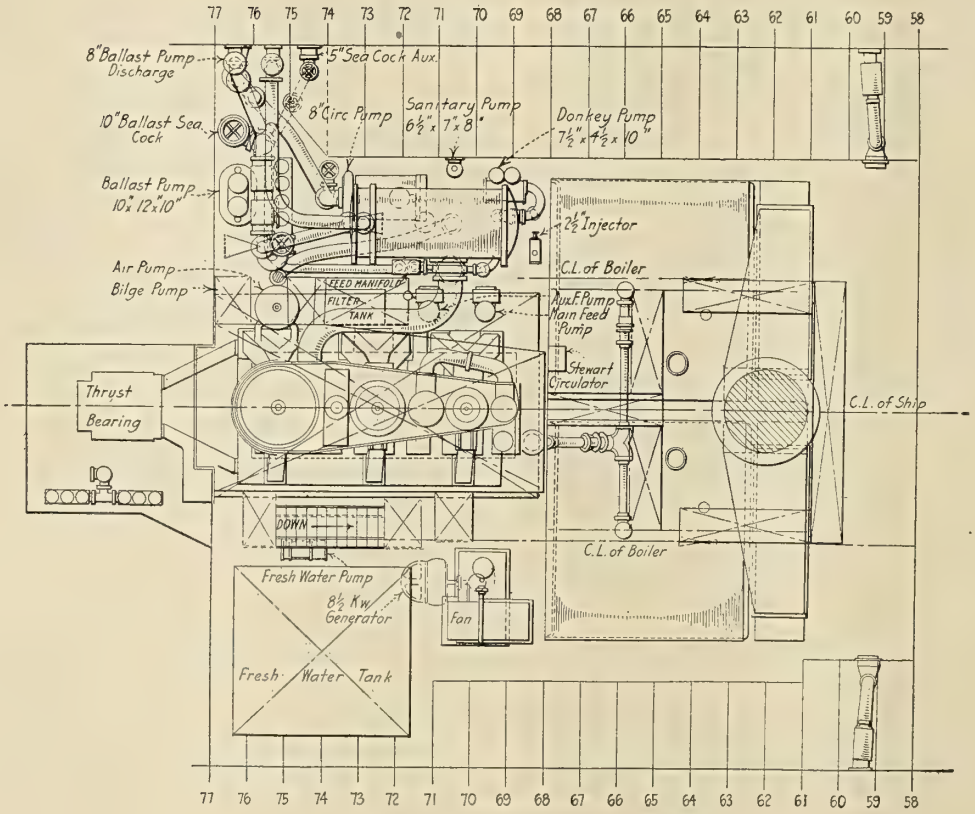
Talk will never build a merchant marine. The more we talk the further away we are from ever having anything approaching a merchant marine. What is required is action—and the quicker we have that action the better it will be for the United States. Thirty years ago Germany saw far enough ahead to know that if she was ever to hope to hold a leading place in the maritime world she had to have ships to do it with. What did she do? The matter was put before the people, especially those who lived in inland states, as a matter of national importance. The German people were quick to see that their future commercial life depended on its merchant marine and promptly told the government that they wanted a merchant marine, with the result that to-day they have one of the finest merchant marines in the world. America can do the same thing that Germany did. She has to-day a better opportunity, a better chance than Germany ever had. She has had the opportunity of benefiting by the important lessons that this war has brought about regarding merchant marines, and surely this great country of ours is going to take this chance that has been offered to her and profit by it.

It is impossible to restore the flag to the wide seas unless remedial and adequate legislation is effected. No enduring legislation is possible unless it is based on an active imperative public sentiment demanding that the American flag be put once more on the seven seas to stay there as long as ships sail the seas.

MACHINERY ARRANGEMENT, S. S. YUNA



Longitudinal Section Through Machinery Space



Plan of Machinery Space



Launch of S. S. *Yuna*

Clyde Line Steamers Built on the Lakes

Description of Welland Canal Size Ocean-Going Freighters Built by the Great Lakes Engineering Works, Detroit, Mich.

THE three steamers, *Yaque, Yuna* and *Inca,* built at Detroit, Mich., in 1915, by the Great Lakes Engineering Works for the Clyde Steamship Company, New York, were designed for a special trade among the West Indies, which limited the draft to 15 feet. On this draft they have a capacity of about 2,000 tons deadweight and a sea speed of about 10 knots.

The vessels were built under special survey to Lloyd's highest class for both hull and equipment. The principal dimensions are as follows:

Length over all	258 feet 6 inches
Length between perpendiculars	246 feet 0 inches
Beam molded	38 feet 3 inches
Depth molded	18 feet 0 inches

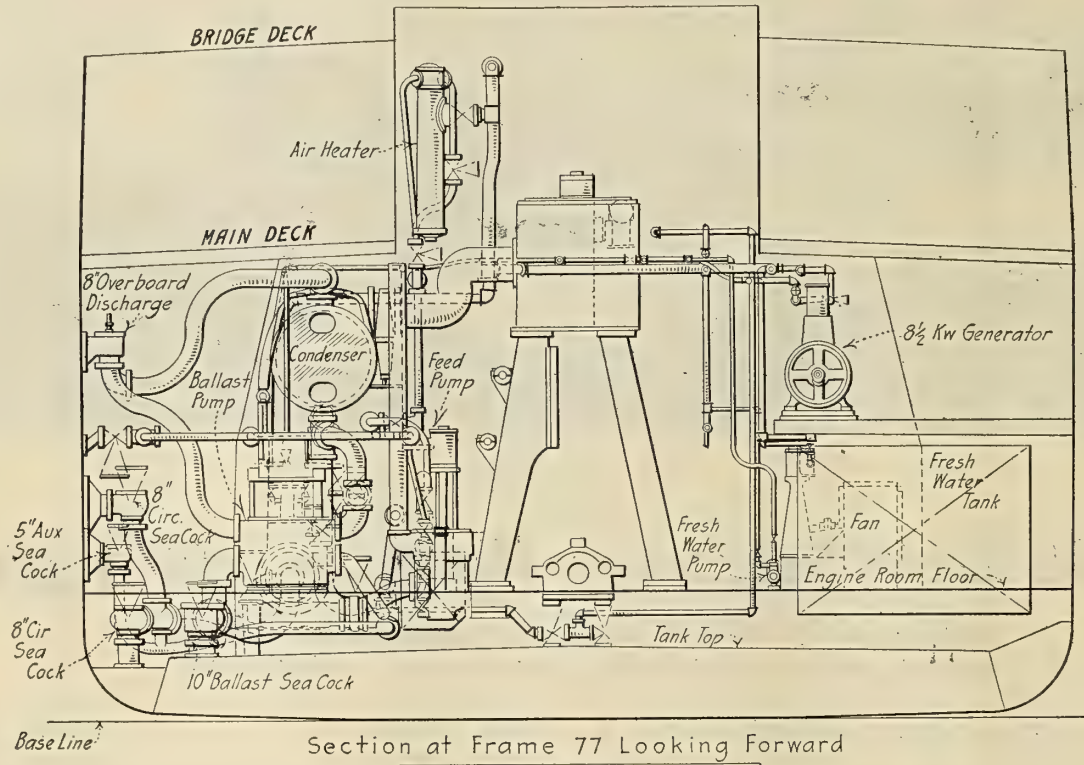
All three vessels are sister ships of the single deck type with forecastle and bridge decks of steel. Quarters for the officers and crew are in the bridge and in an after deck house, respectively. The hatches are as large as possible for the size of the vessel, two of them being 18 feet by 15 feet, one 20 feet by 15 feet, and one 22 feet by 15 feet. The deck is supported by girders and a single row of wide spaced pillar stanchions, leaving the holds practically unobstructed.

Coal is carried in permanent wing bunkers, which run

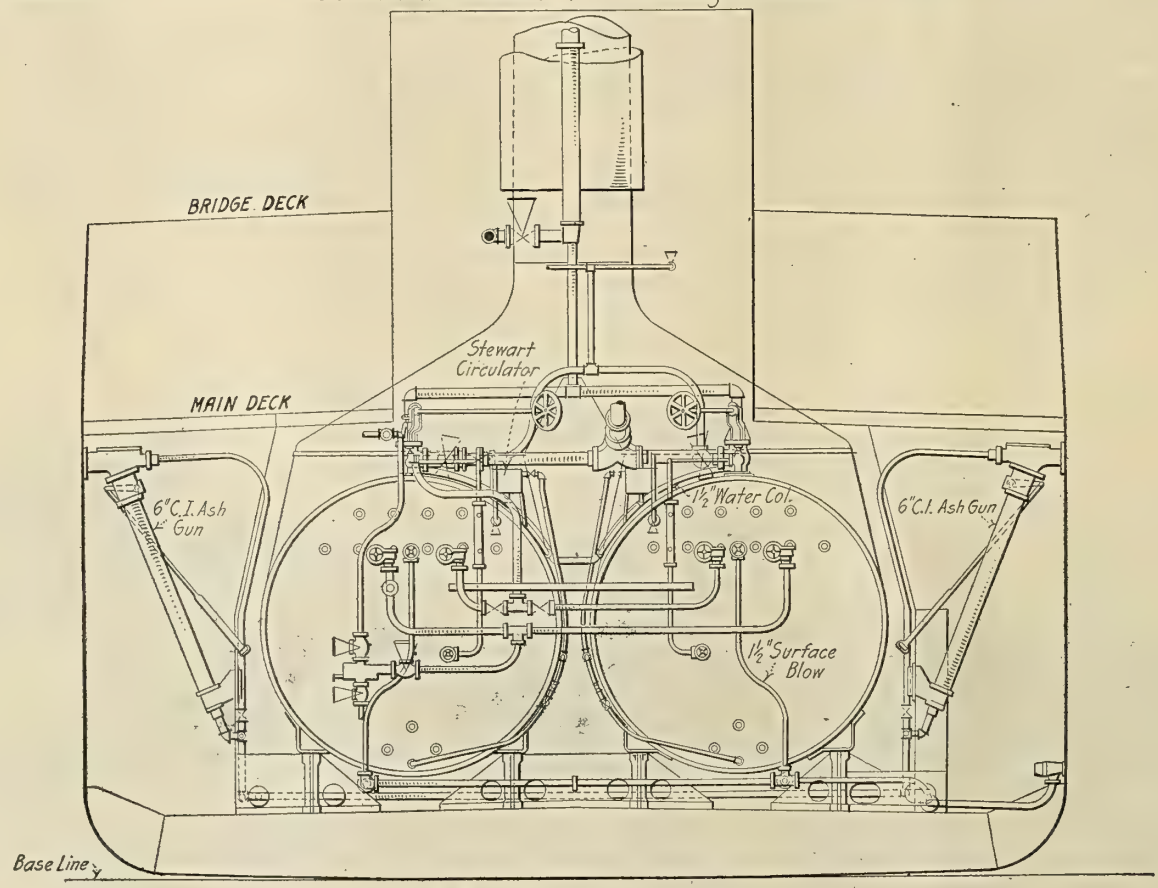


S. S. *Yuna* on the Ways at the Great Lakes Engineering Works

SECTIONS THROUGH MACHINERY SPACE

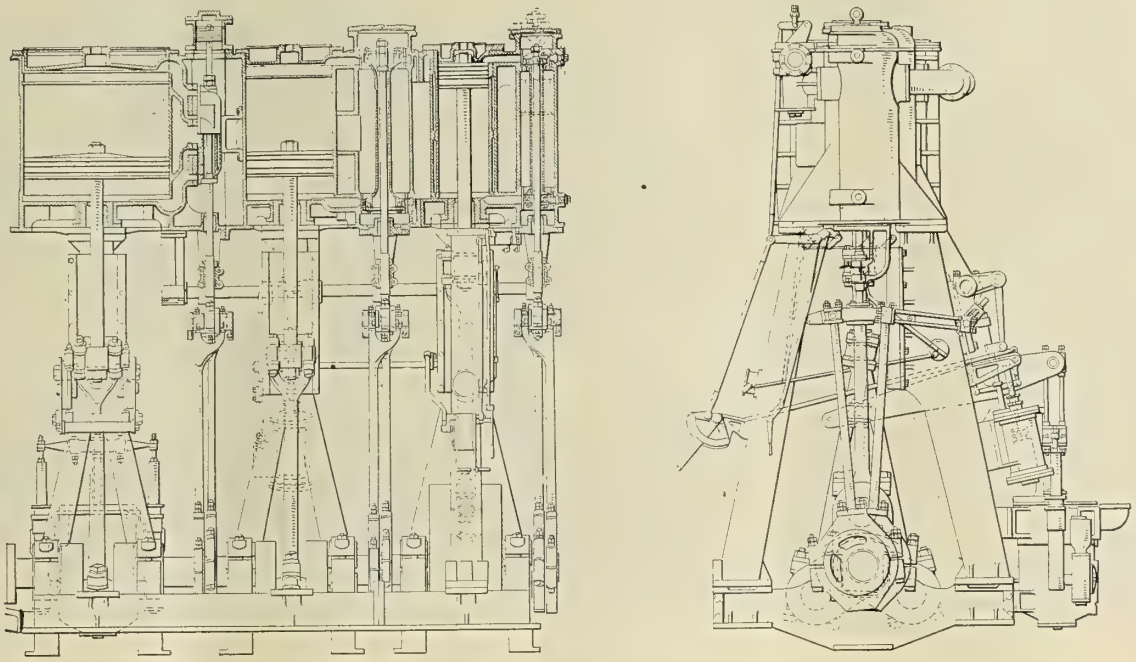


Section at Frame 77 Looking Forward

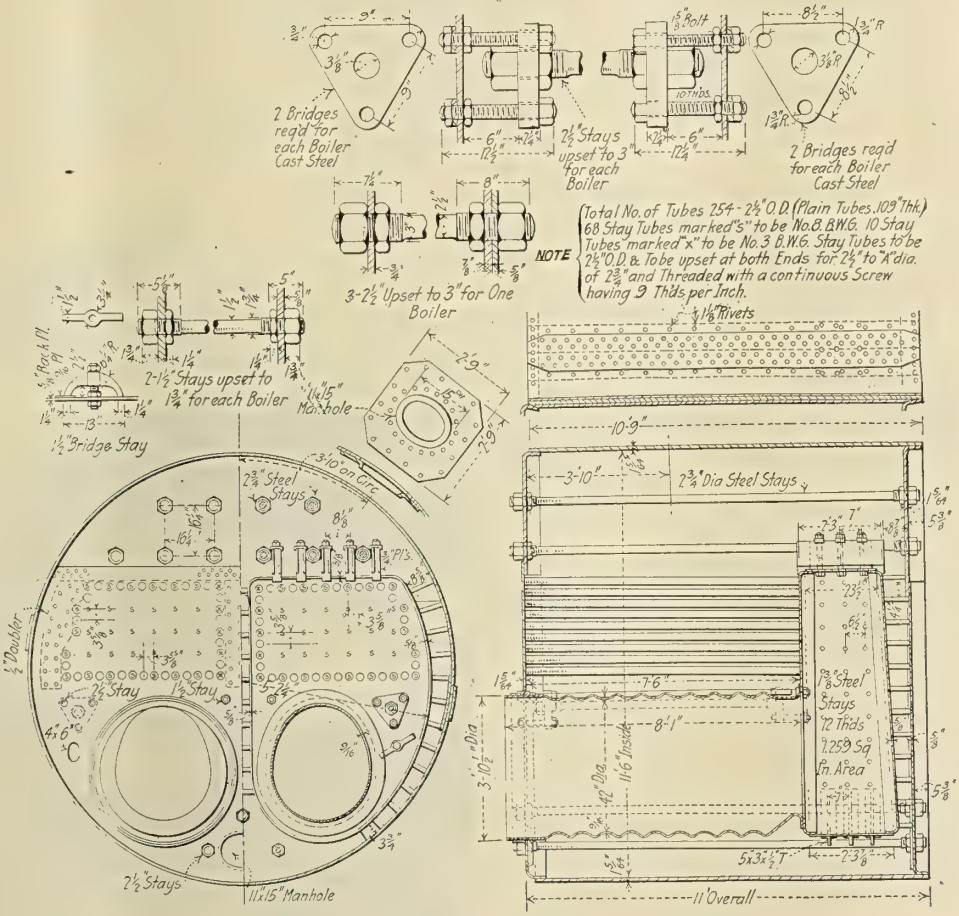


Section at Frame 68 Looking Forward

PROPELLING MACHINERY, S. S. YUNA

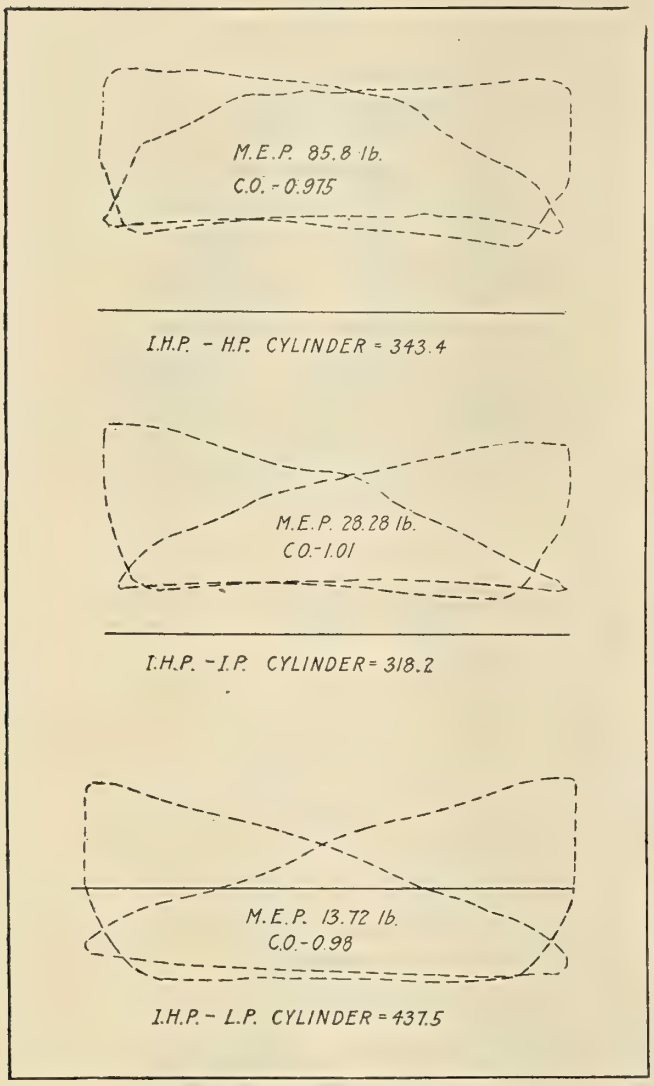


Main Engine



the full length of the machinery space on each side, and in an auxiliary cross bunker just forward of the boiler room. There are also auxiliary bunkers in the bridge. The total bunker capacity is 325 tons, the total water ballast capacity 539 tons and the boiler feed tank capacity 78 tons.

The officers' mess rooms and sleeping rooms are finished on the sides and overhead in oak, but all wood has been omitted from the passageways and the crew's quarters. All floors in the passageways and in the officers' and crew's quarters are of Litosilo. Elsewhere the steel decks are uncovered. The cargo holds have wood

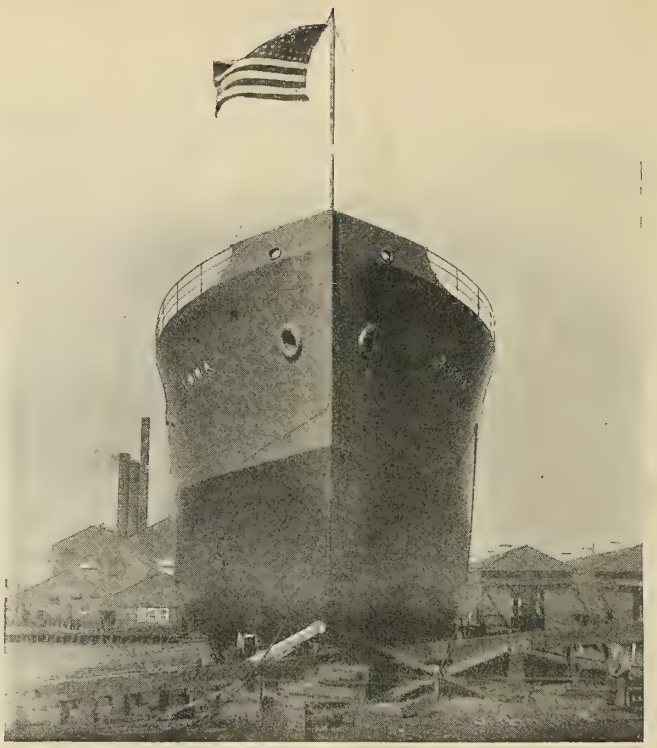


Indicator Cards from S. S. *Inca*

Engine, 17 — 28½ — 48 × 36 inches; boiler pressure, 172 pounds per square inch; vacuum, 24½ inches; piston speed, 582 feet per minute; mean effective pressure referred to low pressure cylinder, 34.4 pounds per square inch; revolutions per minute (average), 96.9; total indicated horsepower, 1,099; slip, 6.46 percent; draft forward, 8 feet 6 inches; draft aft, 12 feet 6 inches; speed, 12.63 miles per hour.

ceilings on the tank top and cargo battens on the sides. Aside from these items there is practically no wood used in the ships.

The cargo handling gear consists of two derrick masts each carrying four six-ton booms, 38 feet long. In addition to this equipment there is a steel boom on the foremast, having a lifting capacity of 30 tons. There are four double drum winches, three of these being 8 inches by 8 inches single geared, and one 8¼ inches by 10 inches double geared, of especially heavy construction, for the 30-ton boom. The standing rigging is of plow steel wire

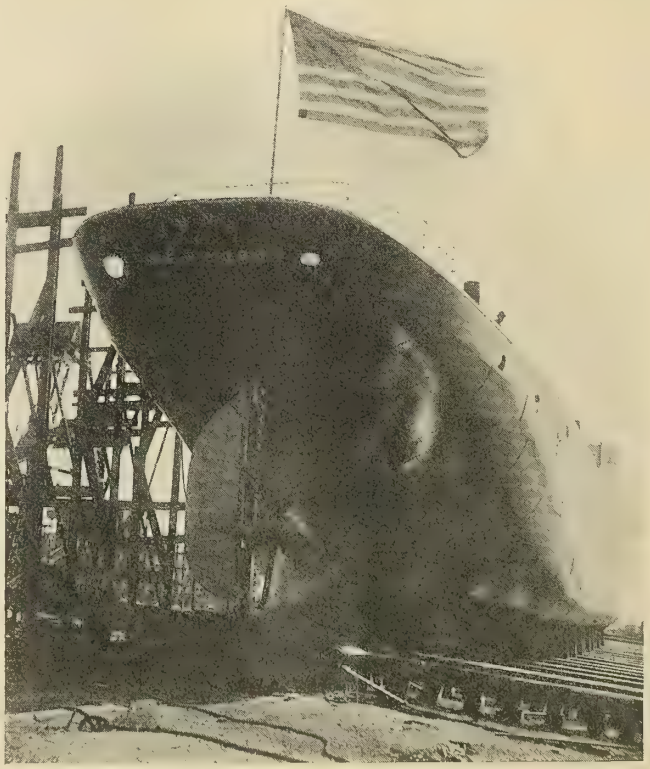


Bow View, S. S. *Yuna*

rope. The running rigging for the 6-ton booms is of durable wire rope, and for the 30-ton boom of plow steel wire. The after winch has an extended shaft with warping heads for handling lines.

There is also a steel windlass on the forecastle deck and the steering engine is located in the after deck house, directly connected to a geared quadrant and controlled by telemotor from the pilot house.

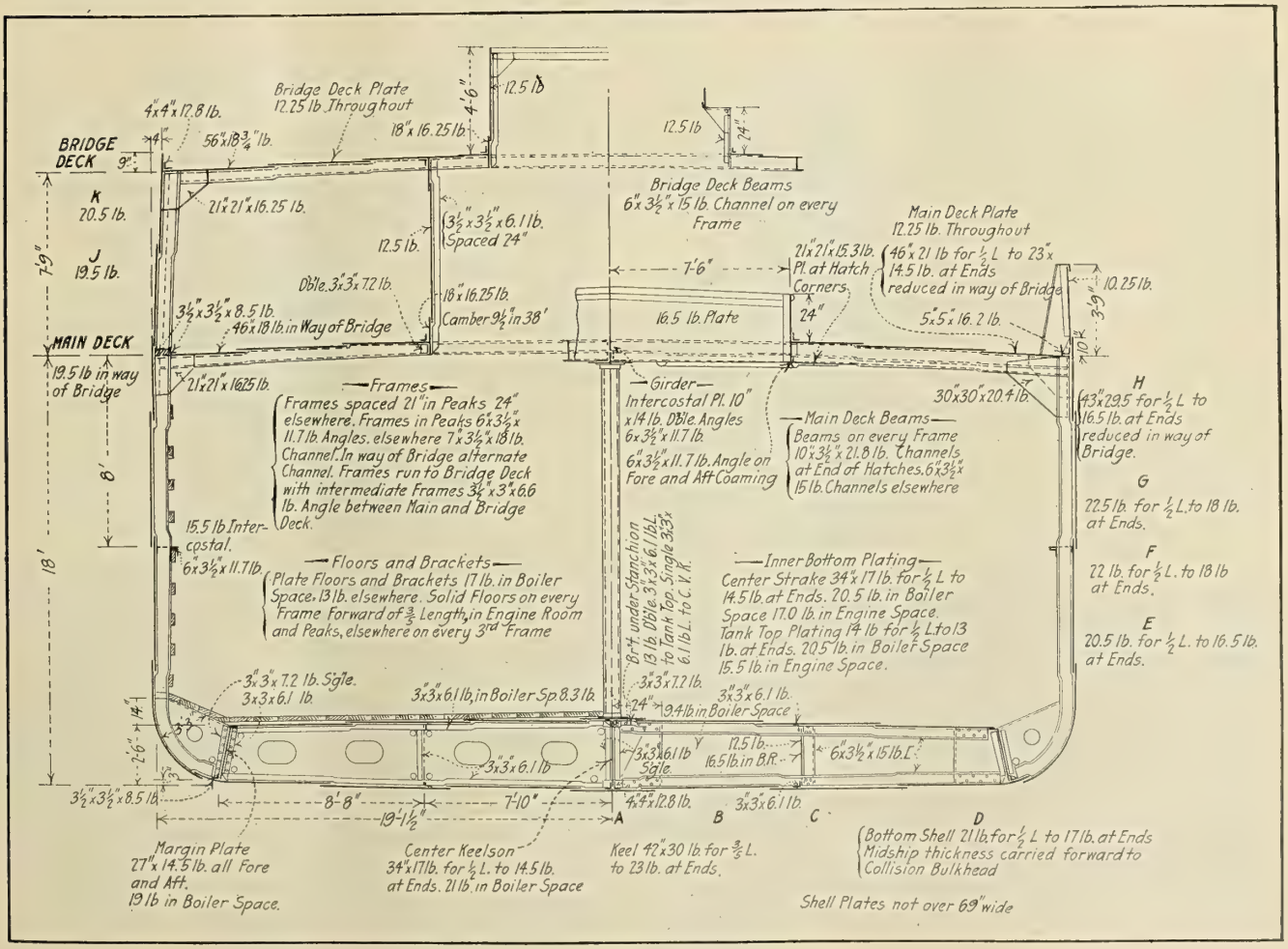
Steam for all working purposes is furnished at 190



Stern View, S. S. *Yuna*



S. S. *Yuna* on Trial Trip



Midship Section

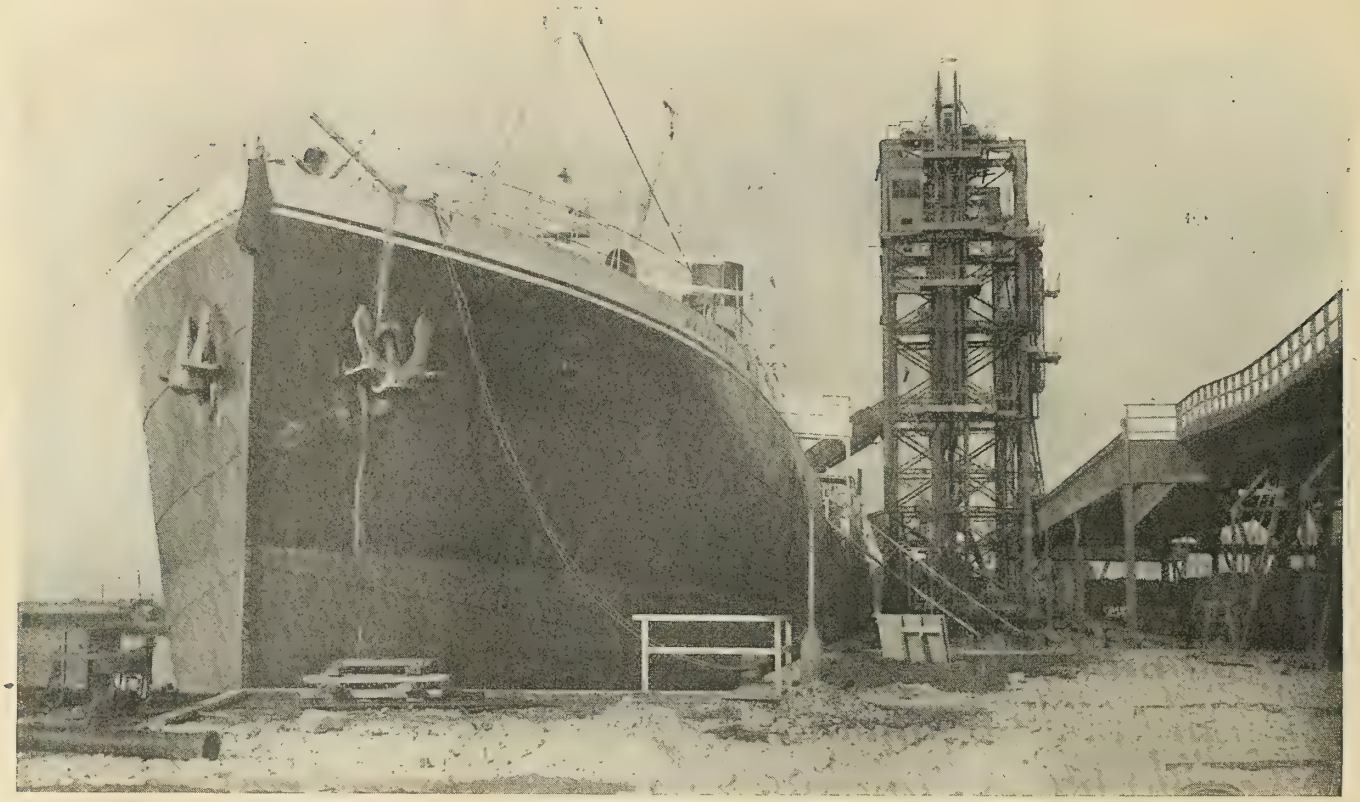


Fig. 1.—Ocean Liner Coaling at King George Dock at Hull

pounds per square inch working pressure by two Scotch boilers, 11 feet 6 inches inside diameter and 11 feet long overall. The shell plates are 1 5/64 inches thick, and each boiler has two 42-inch Morison furnaces and from material 9/16 inch thick. Each furnace has a separate combustion chamber and there are 254 2½-inch tubes in each boiler.

The total heating surface of each boiler is 1,476 square feet, divided as follows: Tubes, 1,246 square feet; furnaces, 85 square feet; combustion chambers, 145 square feet. The grate surface of each boiler (with grate bars 5 feet 3 inches long) is 36¾ square feet, making a ratio of heating surface to grate area of 40 to 1. Through the tubes, the draft area is 8.17 square feet, which makes the ratio of draft area to grate area 1 to 4.5.

Steam is conveyed to the main engines through pipes 6 inches in diameter, fited with 4½-inch stop valves. The auxiliary stop valves are 3 inches diameter.

Main Engines

The ships are all single screw vessels, driven by a solid four-bladed propeller 11 feet 10 inches diameter, having a cast pitch 12 feet 3 inches at the tip. The developed area of the propeller is 55 square feet.

The main engines are of the vertical, inverted, triple expansion type with cylinders 17 inches, 28½ inches and 48 inches diameter with a common stroke of 36 inches. At a speed of 95 revolutions per minute it is estimated that the engines will develop 1,000 horsepower.

In the arrangement of the cylinders the high pressure cylinder is placed forward; following this is the intermediate pressure cylinder and aft is the low pressure cylinder; the crank sequence being high pressure, low pressure and intermediate pressure. Both the high pressure and intermediate pressure cylinders are fitted with piston valves and the low pressure cylinder has a double ported slide valve to the spindle of which a balance piston is attached. The high pressure piston has deep removable solid followers, with spring ring, and the intermediate and low pressure pistons have special metal packing rings.

All the piston rods are 4½ inches diameter. The crossheads are fitted with white metal for ahead and backing faces. The crosshead pins are 4½ inches diameter by 4½ inches long. The connecting rods are of forged construction 6 feet 9 inches long center to center, made from open-hearth steel forgings. The diameter at the top is 4 inches and at the bottom 5 inches. Brass crosshead pin boxes are fitted with bolt adjustment. The crank pin boxes are of cast steel, lined with white metal, and have bolt adjustment. All piston rods and valve stems are fitted with metallic packing.

The crank shaft is of the built-up type, having wrought steel slabs which are shrunk on and doweled. The crank shaft is 9¾ inches diameter and the crank pins 9¾ inches diameter by 10 inches long. The crank shaft is supported by six main bearings 9 inches long.

The thrust shaft is also 9¾ inches diameter. It is fitted with four driving collars bearing against horseshoe shaped white metal faced rings. The outboard shaft is 10¾ inches diameter in the body and 10⅞ inches diameter in the stern bearing, which is 4 feet 2 inches long. The line shafting is 9¼ inches diameter in the body, enlarged to 9½ inches in the bearings, of which there are four.

The auxiliary machinery includes a vertical duplex ballast pump 10 inches by 12 inches by 10 inches; an 8-inch centrifugal main circulating pump, driven by a

6-inch by 6-inch engine; two vertical simplex feed pumps 10 inches by 6 inches by 12 inches; a donkey vertical duplex pump, 7½ inches by 4½ by 10 inches; a vertical, simplex sanitary pump 6½ inches by 7 inches by 8 inches. The bilge pumps are attached to the main engine and are 3½ inches diameter by 18 inches stroke. The air pump, which is also attached to the main engine, and is driven from the high pressure crosshead, is an Edwards pump, 17 inches diameter by 18 inches stroke. There is also fitted to the main engine a direct connecting reverse cylinder 10 inches diameter by 15 inches stroke and a 6-inch by 6-inch single cylinder turning engine. The main condenser has a cooling surface of 1,500 square feet.

Positive draft is furnished by a single blower having a 30-inch wheel, 33-inch suction and a 28-inch by 30-inch discharge. The blower is driven by a 5-inch by 5-inch engine. A feed water heater, 11½ inches diameter by 5 feet 7 inches long, is provided, and the ship is lighted throughout with electricty, current being obtained from an 8½ kilowatt generator driven by a 6-inch by 6-inch engine.

Coal Handling on the British Waterfront

Distinctive Features of Coal Handling Appliances at British Docks—British and American Methods Compared

THE coal handling methods pursued in Great Britain in transferring coal from rail to ship are in part similar to those in use in America and in part dissimilar. There is probably nothing to correspond to the recently built steel piers at Hampton Roads, where the coal is first dumped into special pier cars and then run out on the pier deck, a car elevator having been used in the course of the trip to secure the change of level. However, they do have gravity piers on whose decks the cars are shifted along slight grades by gravity and then returned by gravity down slopes to the "empty" yard.

The steel frame hoisting and dumping tower is used on both sides of the Atlantic. There are differences more or less pronounced between British and American designs. Thus, in America it is customary to divide into two distinct parts the total lift required before dumping. In Great Britain the entire lift is ordinarily accomplished as a single operation. With regard to this difference in practice, there can scarcely be any doubt but that the American system is better. The hoist will have a greater capacity because of the shorter vertical trip. The typical British hoist receives its loaded car of coal at the gen-

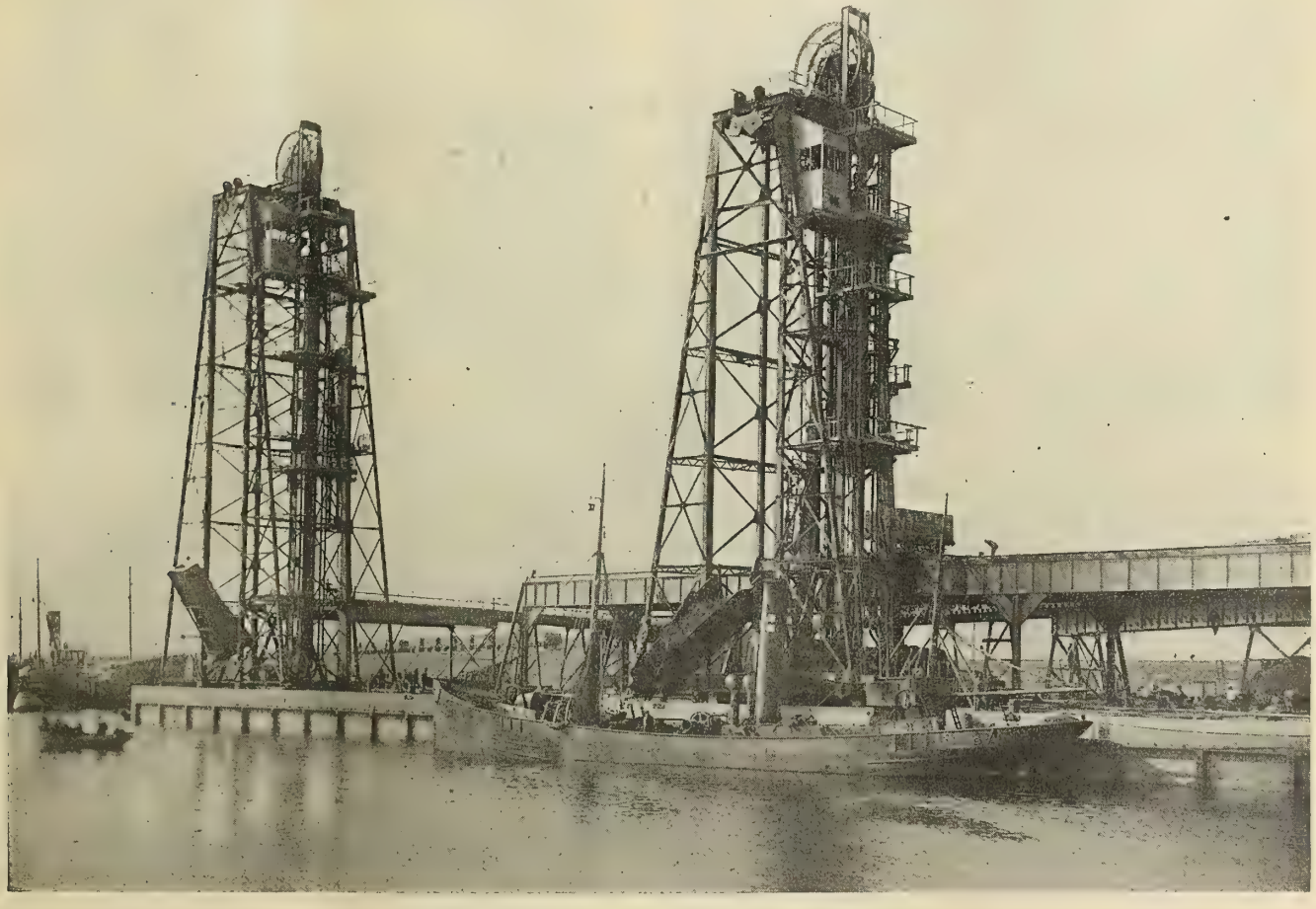


Fig. 2.—Fixed Hoist and Movable Hoist at King George Dock, Hull

eral level, from which point it carries the car to the dumping level and then discharges it.

In America the dumping is differently done. Practically every up-to-date car dumper in the country overturns the car sideways. In Great Britain, on the contrary, the prevailing practice seems to be to dump endwise. In fact, the British method is to *tip* the car, say to an angle of 45 degrees. It is necessary accordingly to provide specially for letting the coal out at the end. The American method is to *overturn* the car—not to tip it. The latest practice with big car dumpers provides for turning the car through 160 degrees. With the British practice the bottom of the car is still the bottom at the time of discharge, while with American practice the *side* of the car becomes the bottom at that moment. This difference in general method makes quite a big difference in the design of the hoist. The British hoists are simpler.

The British coal car has ordinarily a capacity ranging from 10 to 20 long tons. There are some cars, however, of American size. In the United States the typical coal car holds about 40 or 45 tons. The Norfolk & Western Railroad is introducing cars having double this capacity. Naturally, the great difference in weights to be handled makes a difference in the hoists themselves.

The British car coming down empty in the hoist must of course be taken out of the way in order to have things free for the next loaded car. This is accomplished by running the empty car by gravity from some level above the ground over a track sloping down. This track may be carried by a special trestlework or viaduct. This feature is both like and unlike American arrangements. The American car dumper has a gravity run-off, but it is located at the lowest level of the cradle movement. This level is above the general surface, because the hoists themselves are set upon elevations.

The cradle used in Great Britain for controlling the car during the hoisting and discharging period is often very different from the cradle on an American car dumper. The British device may at times be a very simple arrangement, consisting largely of a short length of track arranged on a skeleton platform. Chains, hung to a cross piece or yoke, are secured to this platform and the whole is lifted. The chains are so arranged that the car is tilted upon being lifted up. With this simple device a revolving crane, usable for other purposes as well, may be employed to hoist and swing the loaded car. When the car is in correct position over the hatch of the vessel being loaded the coal is discharged.

The crane may have a runway. In this way provision is made for shifting the vessel-loading arrangements along the face of the dock. The British hoists are sometimes fixed in position and sometimes they are movable.

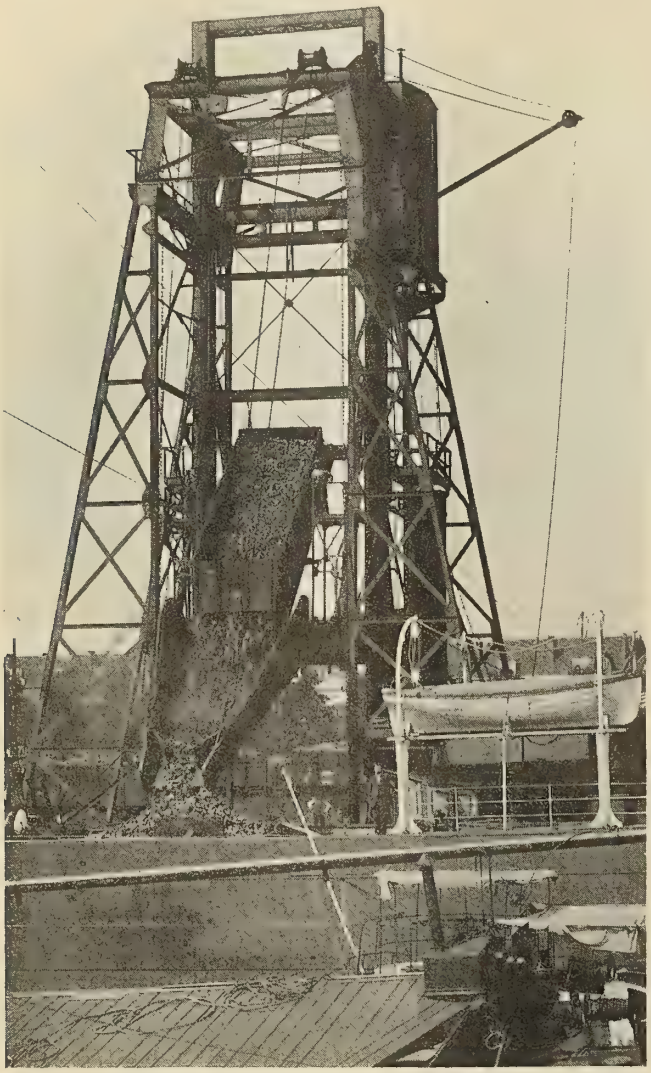
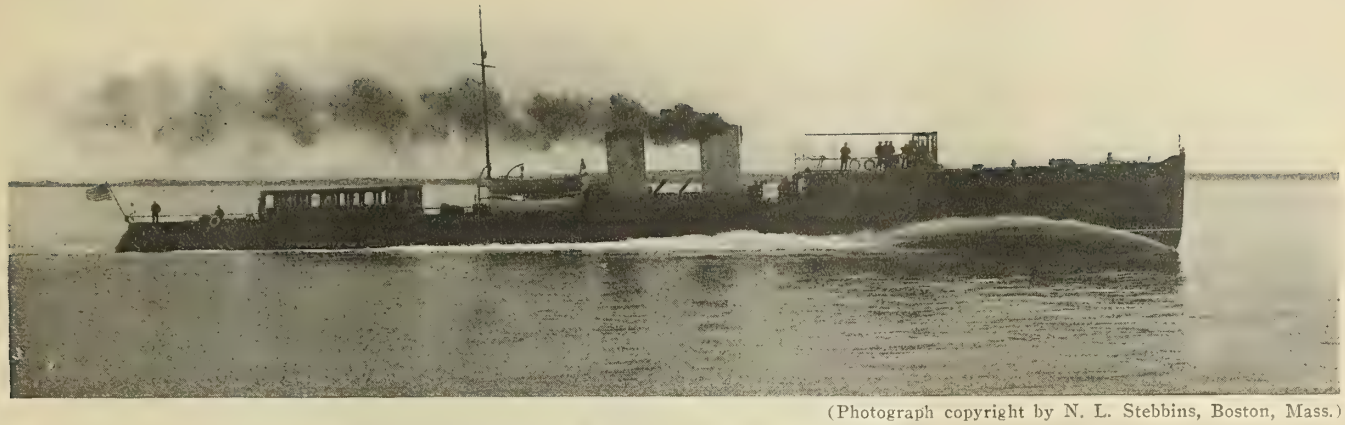


Fig. 3.—British Hoist at Rotterdam



Fig. 4.—30-Ton Movable Hydraulic Crane at North Eastern Railway, Middlesbrough Docks



(Photograph copyright by N. L. Stebbins, Boston, Mass.)

Steam Yacht *Winchester* Bettering Her Contract Speed of 30 Knots

New Steam Yacht Winchester

Turbine-Driven Yacht of Destroyer Type Exceeds Contract Requirements on Trials

ONE of the most notable additions in recent months to the fleet of the New York Yacht Club is the steam yacht *Winchester,* built for Mr. Peter W. Rouss, of New York, by the Bath Iron Works, Bath, Me., from the designs and under the supervision of Messrs. Cox & Stevens, naval architects, New York. The new *Winchester* is the result of the experience of her owner and his naval architects with several very high speed vessels, the last of these, also named the *Winchester,* which was 205 feet long with a speed of 34 knots, now being in the service of the Canadian government.

The hull of the new *Winchester,* 225 feet long by 21 feet beam, is in appearance and form not unlike a modern United States destroyer, with straight sheer, flush deck and cruiser type of stern, the topsides being raised forward for a very considerable distance from the stem with a pronounced flare to the sections above the waterline. The underbody is carefully designed with a view not only to ease in driving at high speeds, but also to meet the owner's requirements for an able sea boat.

Propulsion is by twin screws, driven by Parsons turbines designed to deliver a total of 7,500 horsepower. In each turbine is incorporated an astern turbine, and their design is such that good economy can be obtained at both the cruising and full speeds. Steam is supplied by two Normand oil-fired watertube boilers, located in one stokehold.

The machinery is placed with its center of gravity ap-



(Photograph copyright by N. L. Stebbins, Boston, Mass.)

Wake of the *Winchester* at Full Speed

proximately amidships, the engine room being aft of the boiler room and the fuel tanks partly aft and partly forward at each end of the machinery space. This disposition of the machinery gives the best possible arrangement of weights and the subdivision of the fuel makes it possible to regulate the trim of the yacht at will under all conditions of loading.

The yacht was designed for a speed of 30 knots, but her official trials carried out over the government's course at Rockland, Me., developed a speed of 31.6 knots.

The general arrangement of the yacht is of special interest, as it shows the results of careful study of the conditions imposed by the owner for comfortable living and efficient operating quarters. As shown by the photographs, there is a forward and after deckhouse on the main deck, the top of the forward deckhouse being at the same level as the forecastle deck. The dining room, which is at the after end of the raised forecastle, is 20 feet by 15 feet, and forward of this is the pantry, below which on the berth deck is the galley. In the raised forecastle forward of the pantry are the officers' quarters and below on the berth deck are the crew's quarters.

The after deckhouse, which is 29 feet by 15 feet, contains the main living room, from which a stairway leads to the owner's and guests' quarters on the berth deck aft. The decorations and furnishings of the living quarters are in harmony with the design of the yacht and every convenience is provided. The deckhouses, skylights, rails, companionways and other outside deck work are of teak instead of mahogany.

The yacht is equipped in the most complete manner throughout, having steam heat, electric lights, steam capstans and steam steering gear. The equipment of boats includes a 26-foot high speed owner's launch, a 25-foot crew's launch, both equipped and passed as lifeboats, and a 16-foot dinghy.

Test of Ward Watertube Boiler*

Naval Board Makes Exhaustive Tests of Ward Type of Watertube Boiler—Data and Conclusions

BY LIEUTENANT S. M. ROBINSON, U. S. N.

A Ward boiler was tested at the plant of the Charles Ward Engineering Works, Charleston, W. Va., recently by a board consisting of Lieutenant Commander H. C. Dinger, U. S. N., Lieutenant S. M. Robinson, U. S. N., Lieutenant A. M. Penn, U. S. N., and Mr. A. Conti.

Particulars of the boiler tested are as follows:

Type of boiler.....Ward Straight Tube
Total tube heating surface.....4,405 square feet
Volume of furnace.....476 cubic feet
Fuel used.....Elk Refining Co., paraffine base
Number of burners.....7
Type of burners....Bureau of Steam Engineering, Type I

The boiler was fitted with wooden air box at front, fitted with air lock. Air was supplied by means of a motor-driven Sturtevant blower. As the blower motor was of the constant-speed type, the air supply was regulated by means of a butterfly shutter in blower discharge and a sliding door on front of air box.

Feed was supplied by means of two horizontal Blake plunger pumps discharging through two Reilly feed-water heaters.

Oil was supplied by means of two Blake horizontal, piston, simplex oil pumps, discharging through Reilly oil-fuel heater (coil type) to the fuel-oil main at boiler front; a special air chamber was fitted on the discharge line. There were fitted in addition three large air chambers

* Abstract of article from Journal of American Society of Naval Engineers.

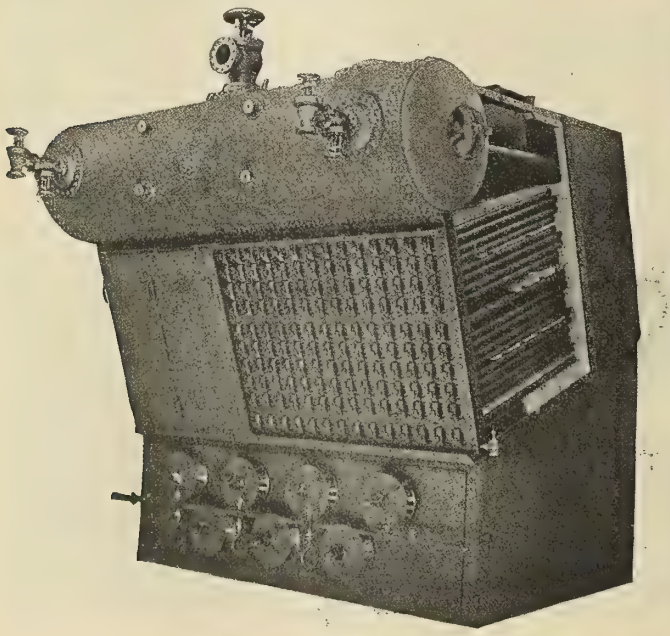


Fig. 1.—Ward Test Boiler

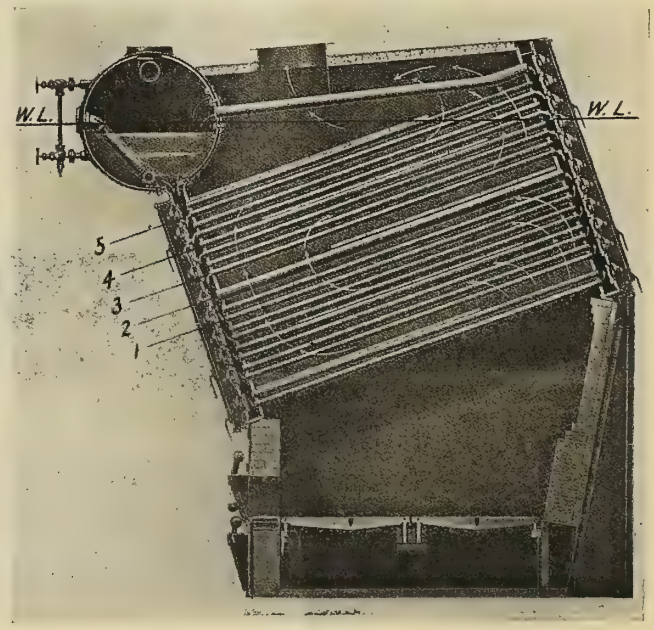


Fig. 2

DRUM AND HEADERS OF WARD BOILER

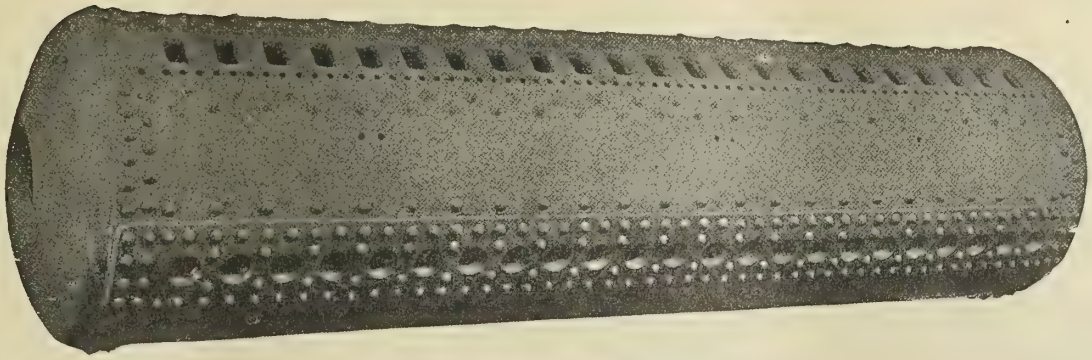


Fig. 3.—Steam Drum

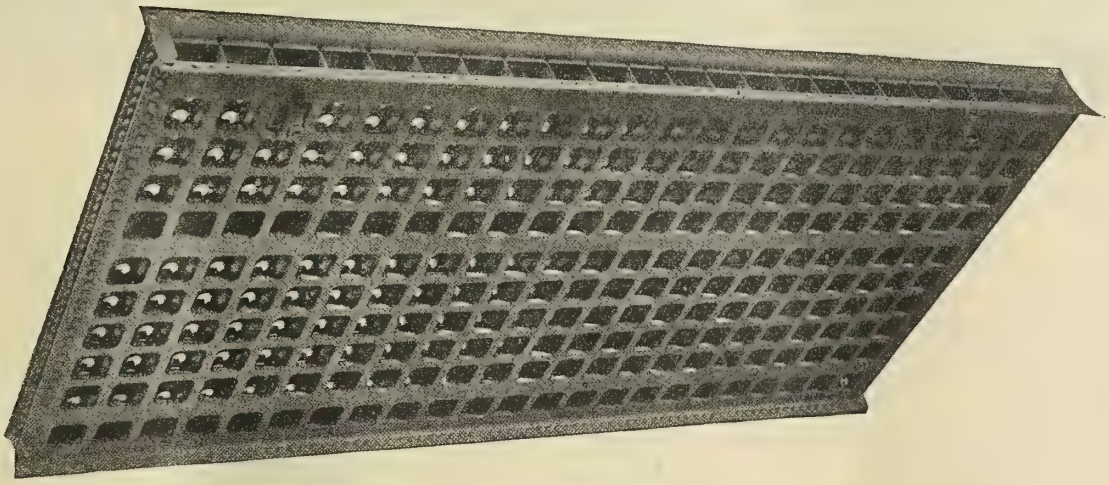


Fig. 4.—Front Flitch, or Header

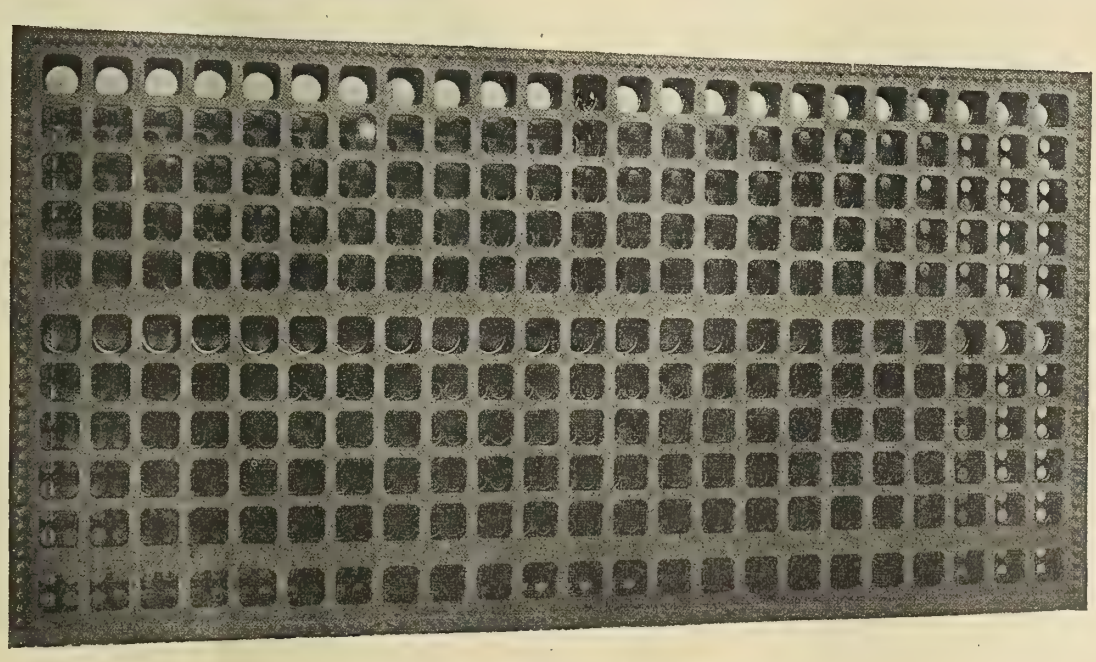


Fig. 5.—Back Flitch, or Header

near oil heater to reduce fluctuations in pressure. The oil used was Elk Refining Company's paraffine-base West Virginia oil, of the following characteristics:

Specific gravity at 60 degrees	.8245
Baume, degrees	40.1
Flash point, degrees F.	144
Fire point, degrees F.	270
Viscosity (Engler), at 60 degrees F.	9.25
Acidity	None.
B.T.U.	19,879
Sulphur	None.

Three tests were run, the first test to determine the efficiency of the boiler when burning oil at the rate of 2,300 pounds of oil per hour, the second when burning oil at the rate of 1,500 pounds of oil per hour, and the third

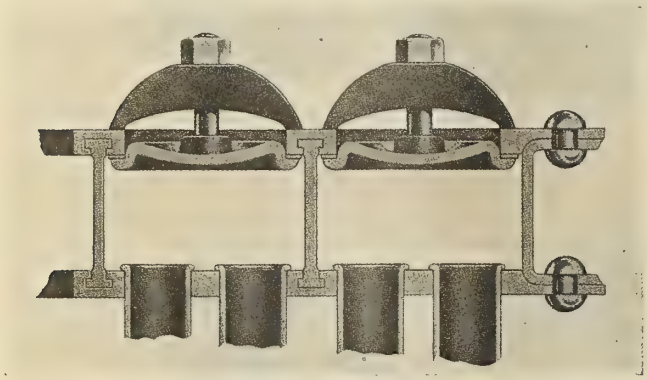


Fig. 6.—Section Through Wrought Steel Header, Showing Method of Staying the Tube and Handhole Sheets

test when burning oil at the rate of 3,100 pounds of oil per hour.

Test No. 1.—Approximate rate, 2,300 pounds of oil per hour. Test begun 5 P. M., February 7, 1916, ended 11 P. M. February 7, 1916. Seven burners fitted with 5/64-inch tips and 3/64-inch plugs were used.

Two oil pumps, two feed pumps, two feed heaters were in operation throughout the test.

There was some vibration on several occasions during the trial due to lack of care with air regulation.

There was no observable smoke during the entire trial. A small excess of air was supplied.

At 8 P. M. one feed pump broke down and operated indifferently during the remainder of run.

The casing of the boiler, especially the left side in wake of lower rows of tubes at back, became red hot in places, indicating insufficient lagging behind the brick.

Test No. 2.—Approximately 1,500 pounds of oil per hour. Test begun midnight, February 7, 1916, ended at 6 A. M., February 8, 1916. Seven burners were used. The burner used was 1/16-inch tip and 3/64-inch plug.

One oil pump, one feed pump, one feed heater were in operation.

The conditions were very steady during the entire trial. The combustion was excellent. The casing became quite hot at sides near back of boiler.

There was no observable smoke during the entire run.

At end of test boiler was let down, brickwork appeared in very good condition; the bottom appeared to be somewhat uneven, indicating that magnesia under bricks was disintegrating to some extent.

During February 8 the feed pump was overhauled. Additional asbestos millboard was placed behind metal side casing, and the brickwork, especially that on left side of boiler, was repaired.

Test No. 3.—Approximate rate, 3,100 pounds of oil per hour. Fires were started at 12.30 P. M., February 9, 1916. Data for test were taken from 1.30 P. M. Test ended 6.30 P. M. On account of insufficient time to get boiler warmed up to proper conditions, it was decided to use data for four hours, from 2.30 P. M. to 6.30 P. M. Seven burners were used. The burner used was 3/32-inch tip and 3/64-inch plug.

Two oil pumps, two feed pumps and both feed heaters were used.

Owing to lightness of oil, difficulty in forcing a sufficient amount through the burners was experienced when oil was heated. The oil was therefore not heated after the first hour. With cold oil the required amount of oil was burnt.

There was no observable smoke during the entire run.

The left side of casing became red hot during test, indicating that there is insufficient insulation in casing as built.

Synopsis of Tests

Test No.	2	1	3
Approximate rate of oil burned per hour required by schedule 7,360	1,500	2,300	3,100
Oil actually burned, pounds per hour	1,509.7	2,440.7	3,082
Pounds of water evaporated from and at 212 degrees F. with oil as fired of 19,879 B.T.U.	16.73	16.48	16.21
Reduced to 19,000 B.T.U.	15.99	15.75	15.49
Guaranteed for 19,000 B.T.U.	15.66	15.33	15.00
More than guaranteed	.33	.42	.49

Comments on Operation of Boiler

The boiler steamed freely under all the tests. The circulation is evidently satisfactory. Small propellers were placed in two of the intermediate 4-inch tubes, with a rod running through the handhole. The movements of these rods indicate a down-flow in the 4-inch tube at all rates of steaming.

After the regular test the Charles Ward Engineering Works, at the suggestion of the Board, installed propellers

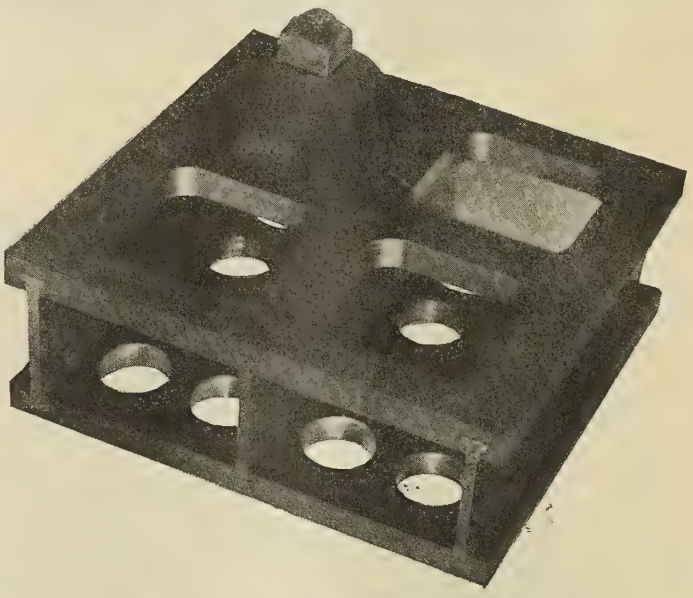


Fig. 7.—Section Showing Header Construction

in several of the 2-inch tubes to ascertain the character of the circulation. (See Fig. 2.) The result was as follows:

No. 2 began to revolve in about five minutes after the fires were started; the direction of rotation showed down-flow in these tubes. No. 1 hesitated slightly, showing some inclination to turn left-handed, which was probably due to the suction caused by the down-flowing water from No. 2. This condition changed before steam was raised, and No. 1 began to revolve in the opposite direction,



U. S. S. Destroyer *Sampson*, built by Fore River Shipbuilding Corporation, Quincy, Mass. Contract Speed, 29.50 knots; Trial Speed, 31.30 knots.

showing that the water was flowing up the lower bank of 2-inch tubes. Nos. 3 and 4 began to revolve left-handed in about ten minutes after the fires were lighted, the speed increasing until they were running like windmills, so fast that the revolutions could not be counted; the direction of rotation showed down-flow in these tubes. No. 5 remained stationary until there was about 50 pounds of steam on the boiler, and then it commenced to revolve in a left-handed direction, indicating that as soon as the water level raised on the high side of the tubes, due to the steam-making condition, there was a down-flow through the 2-inch tube mentioned.

From these experiments it is inferred that the flow is upward through all the 2-inch tubes below the middle baffle, and downward through all the 2-inch tubes in the upper portion of the boiler, the velocity being quite rapid, for, as stated, the propellers were revolving in the neighborhood of 200 revolutions per minute or more. The high velocity of the propellers in the small tubes is due to the fact that the shafts were of very small diameter and consequently there was very little friction in the apparatus.

Tabulated Results of Tests

1	Test No.	2	1	3
2	Barometer	30.79	30.73	30.55
6	Steam pressure, pounds gage	194.75	196	197.6
9	Feed temperature of boiler, degrees F	183.6	113	168.3
12	Oil pressure at burners, pounds gage	258	255	283
13	Oil temperature at burners, degrees F	163	141	50.5
14	Fireroom pressure, inches of water	2.34	4.91	4.96
15	Fireroom temperature, degrees F	62	74	64
16	Stack temperature	418	475	520
17	Smoke, Ringelmann scale	0.1	0.1	0.1
18	Carbon dioxide	12.48	12.61	13.14
19	Oxygen	3.08	2.97	1.89
20	Carbon monoxide	....	....	....
21	Nitrogen (by difference)	84.44	84.42	84.97
22	Moisture in steam, fraction of 1 percent	.616	.606	.69
23	Factor of evaporation	1.0738	1.1466	1.089
24	Pounds of water evaporated per pound of oil	15.59	14.37	14.89
27	Water evaporated per square foot of heating surface per hour, actual	5.342	7.964	10.415
28	Water evaporated per square foot of heating surface per hour, from and at 212 degrees F.	5.736	9.131	11.34
29	Pounds of oil burned per square foot of heating surface per hour	.3427	.5541	.6996
30	Pounds of oil burned per cubic foot of furnace per hour	3.17	5.125	6.475
31	Boiler efficiency, percent	81.68	80.45	79.13

To establish the volume of water flowing down through the 4-inch tube, one of the propellers was removed and installed in a short piece of pipe (as shown by the accompanying sketch), this being connected to the city water main and the propeller operated under a pressure of about 40 pounds, the discharge being throttled until the propeller made approximately the same number of revolutions as it did in the boiler. Readings from the water meter over a period of five minutes showed that there was about 50 gallons per minute passing through this tube. This, however, is only an indication of the amount of water flowing through the 4-inch tubes, as the friction on the propeller was very much greater under the higher pressure conditions existing in the boiler.

The foregoing results are very interesting, and are believed to throw a new light upon the problem of circulation in boilers of this general type of construction. They also indicate that the baffling as arranged secures the benefit of the counter-current principle throughout the boiler.

The casing as constructed is insufficiently insulated for high rates of combustion. This can, however, be easily remedied by providing additional insulation, and, if brickwork is provided with anchor bolts, injury due to panting will be avoided.

No distortion of any of the lower tubes was observed, and it is apparent that there is no difficulty in giving the lower tubes an ample supply of water.

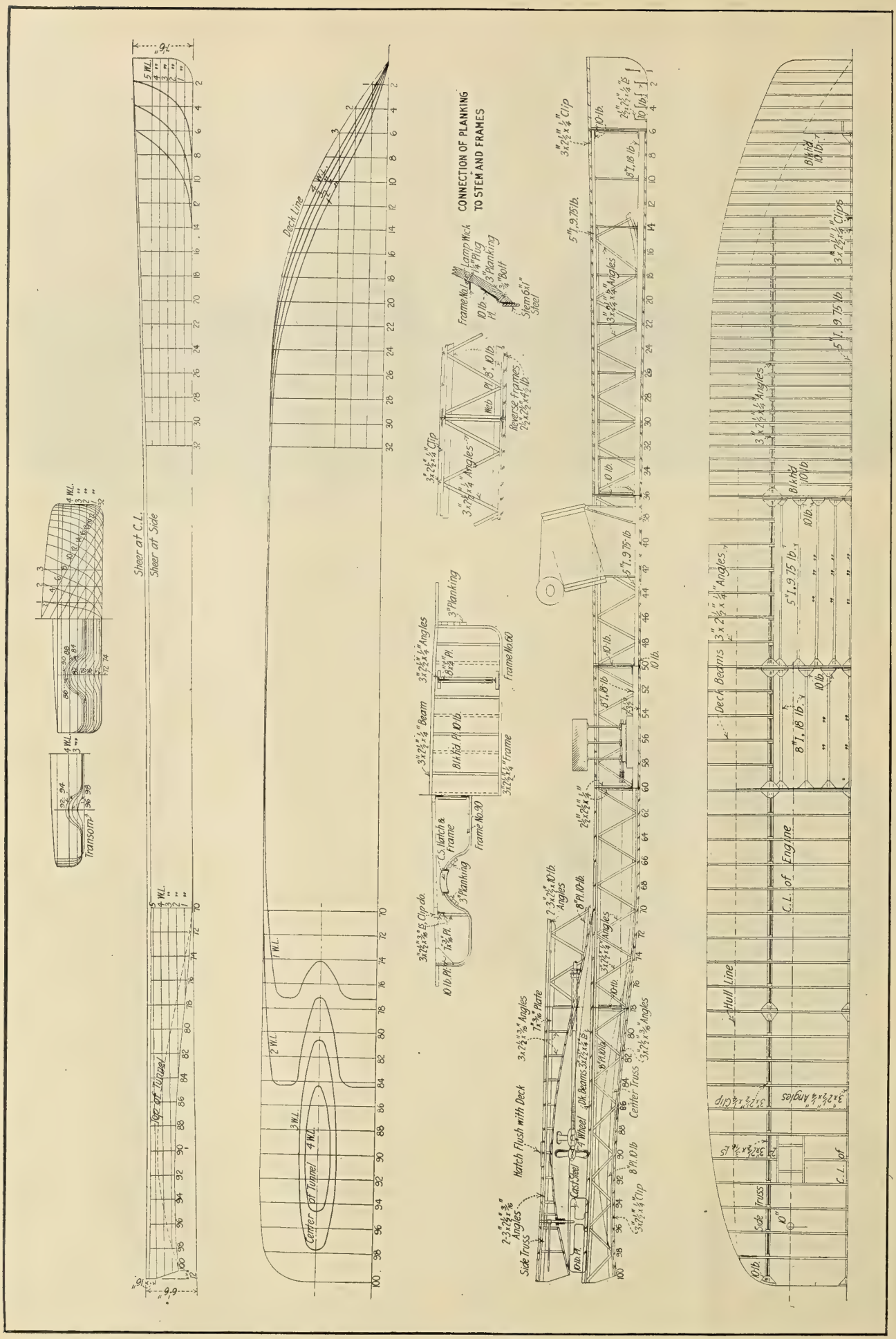
Comments on Design of Boiler

The design gives a very compact straight tube boiler with good circulation.

The baffling as arranged gives a counter flow action between water and gases through the boiler, which apparently secures very high efficiency.

The manner of staying the water chambers is considered efficient, and no trouble should be expected from the design of water chambers.

There is ample space in the header beneath the edges of the lower tubes to allow for the collection of sediment, should this be contained in the feed water.



Lines and Construction Plans of Twin-Screw Tunnel Stern Excursion River Boat

Twin Screw Tunnel Stern Excursion River Boat

The drawings on the opposite page show the lines and construction plans of a twin screw, tunnel stern, shallow draft excursion boat, 150 feet long by 28 feet beam by 5 feet depth, designed by Mr. E. O. Paterson, naval architect, Alexandria, Va., for use on the Ohio River. The boat will have a displacement of 241 long tons on a draft of 2 feet 3 inches.

Owing to the slow delivery of steel, the hull is of composite construction with steel frames and 3-inch Georgia pine planking. As the boat is not required for towing, only two rudders are provided.

Propulsion is by twin screws, 4 feet diameter by 96 inches pitch, designed to run at 250 revolutions per minute to give the boat a speed of 12 miles per hour, being driven by high pressure compound engines supplied with steam by watertube boilers.

Motor Ship Oregon

The motor ship *Oregon,* built for Det Forenede Dampskibselskab (The United Steamship Company) by Burmeister & Wain of Copenhagen, carried out her official trial trip in the Copenhagen Sound on April 15 and 17.

The *Oregon* is a sister-ship to the first motor ship for Det Forenede Dampskibelskab, the *California,* and is built to replace the steamship *Maryland,* which was built of the same deadweight capacity as the *California,* in order to get a real basis for comparison of the economy of a Diesel ship with four-stroke engines and a thoroughly modern steamship.

Unfortunately, the *Maryland* was blown up by a mine on the home voyage, but there was already sufficient results for Det Forenede Dampskibselskab to resolve to replace the *Maryland* with a motor ship.

The main engines of the *Oregon* are six-cylinder, four-stroke, single acting Diesel engines with a cylinder diameter of 23.6 inches and a stroke of 36 inches, developing as normal load 2,800 indicated horsepower at 140 revolutions per minute. Each engine drives its own main compressor of the Burmeister & Wain standard three-stage type for air injection.

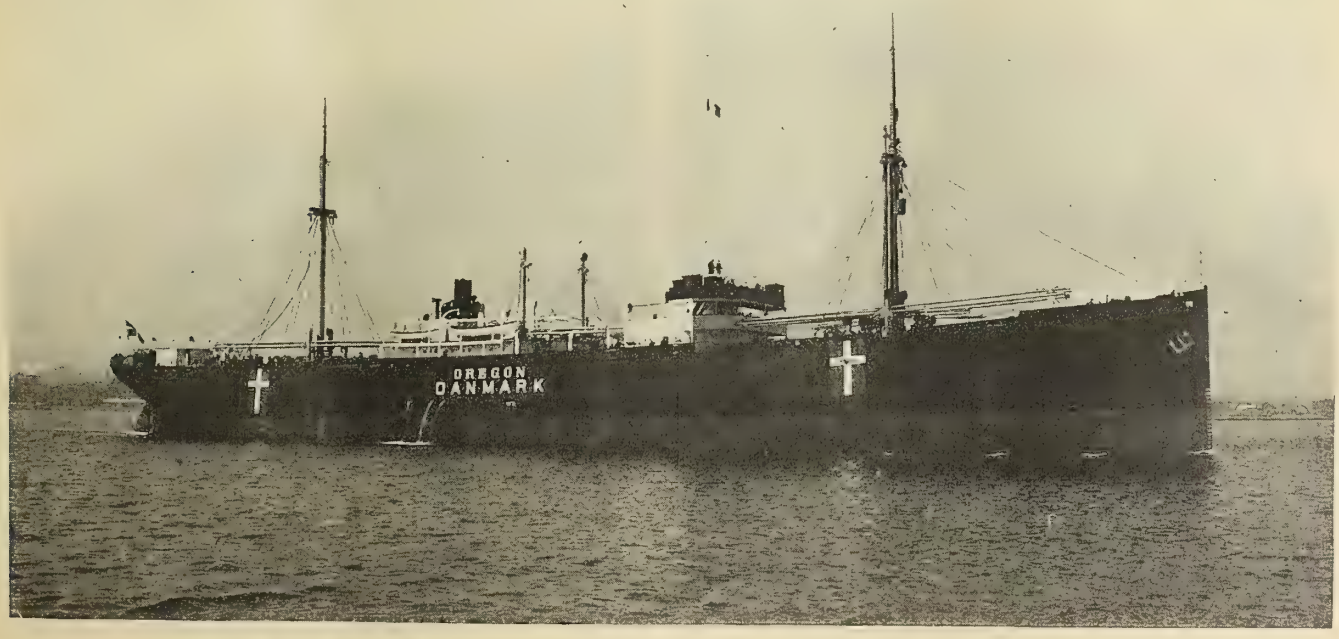
The three auxiliary Diesel engines develop each 75 brake horsepower at 325 revolutions per minute, directly coupled to dynamos of 50 kilowatts at 220 volts, all the auxiliary machinery, winches, anchor windlass and steering gear being electrically driven.

For heating purposes there is arranged a small boiler, and in connection with this a smaller auxiliary compressor, for filling up one of the high pressure air bottles if all the air should be lost on account of an error by the staff or if the ship has been laid up.

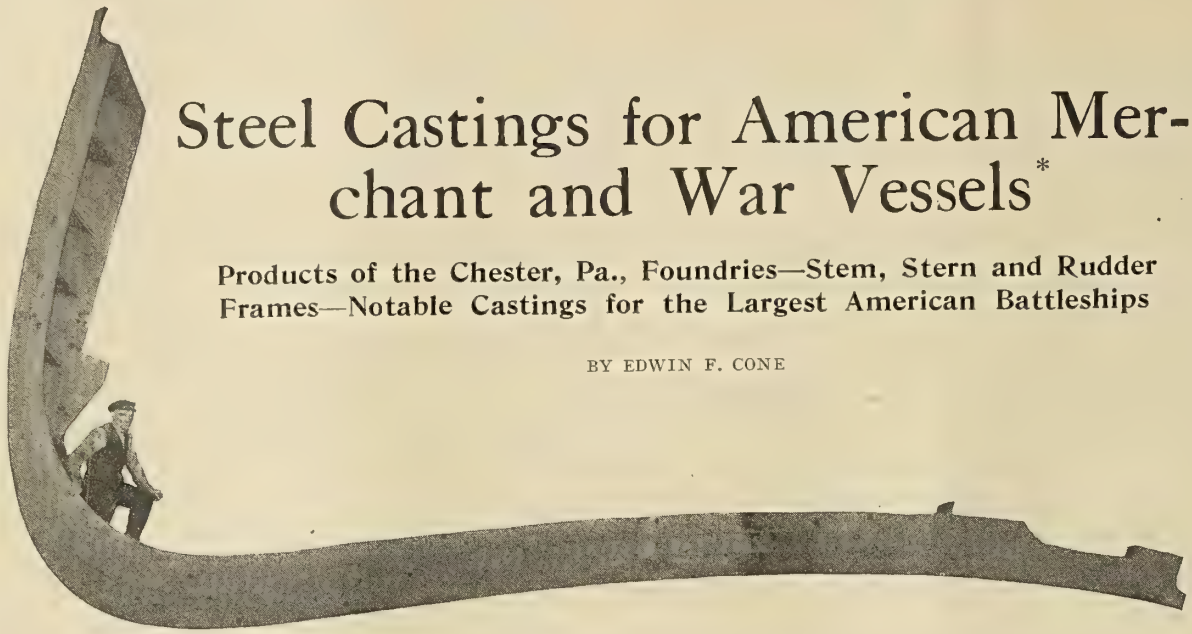
The trials on the 15th consisted of progressive runs over the measured mile, and on the 17th the fuel consumption was measured on a three-hour consumption test. A speed of 12.49 knots was obtained at 2,900 indicated horsepower and 148 revolutions per minute. As the trials were entirely satisfactory to the owners, the ship started on her maiden voyage for America on April 18.

Difficult Repair Job at Sea.—Reports from Lloyds describe a difficult piece of engineering repair work carried out by the officers and engineers of the steamer *Pukaki,* of 1,444 gross tons, owned by Messrs. William Clancy & Co., while adrift in the Pacific. The vessel was bound from Sydney to Ocean Island, and while off the island of Kusail the tailshaft of the steamer broke. The propeller was unshipped and the broken tailshaft removed, but when an attempt was made to fit the spare shaft, it was found to be ⅛ inch too large at the inboard end and ⅝ inch too large at the outboard end. After eight days of arduous labor with hand tools the shaft was fitted and the vessel proceeded to her destination. The work was carried out by Mr. W. J. Meek, chief engineer, Mr. W. Newlands, second engineer, and Mr. Williamson, third engineer.

Power Barge Service Between Philadelphia and New York.—A power barge freight service, known as the "Blue B" line, is now in operation between Philadelphia and New York via the Delaware and Raritan Canal. Daily sailings are offered and the trip is made in about fifteen hours, the barges now in use averaging 125 tons capacity. A regular schedule is maintained, a boat leaving Philadelphia and New York at four o'clock in the afternoon, except Sunday, arriving at their destinations at seven o'clock the next morning. The freight rates by water are the same as by rail.



Motor Ship *Oregon,* Built by Burmeister & Wain, Copenhagen, for the United Steamship Company



Steel Castings for American Merchant and War Vessels*

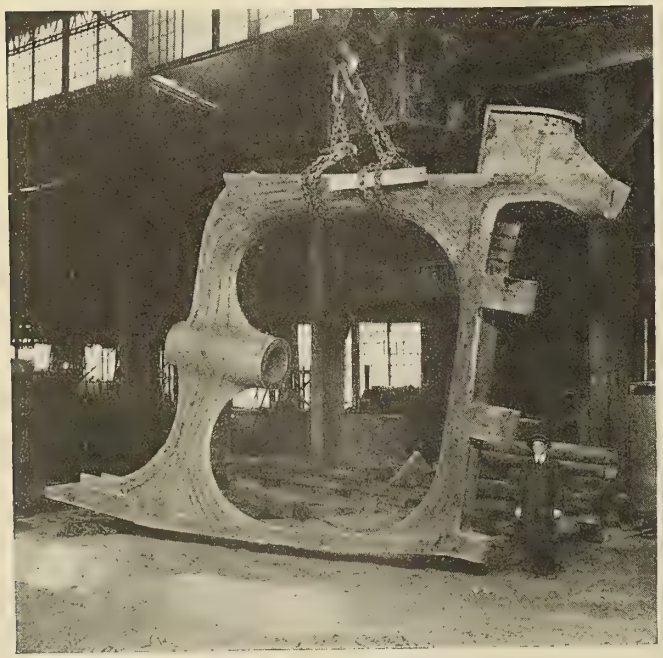
Products of the Chester, Pa., Foundries—Stem, Stern and Rudder Frames—Notable Castings for the Largest American Battleships

BY EDWIN F. CONE

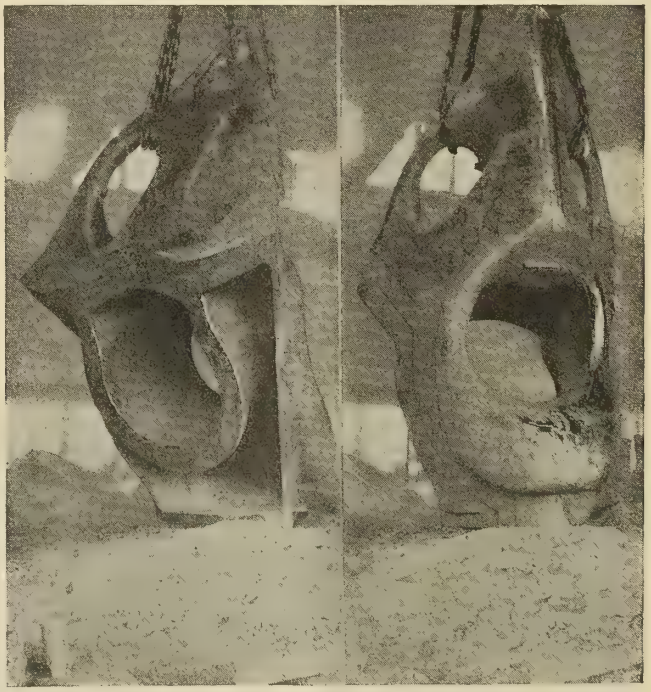
PROBABLY 90 percent of the steel castings required to build the new navy of the United States have been made in Chester, Pa. In that city are located several of the most important open-hearth steel foundries in the country. In their employ are many men who have spent their lives in the various foundries and have helped to develop this remarkable phase of the foundry business, so that this district is famous for the battleship and other ship castings it has produced, not only for our own navy, but for those of other countries. Many intricate and large castings for the present additions to the navy are still being made by Chester foundries.

Four important types of large castings enter into the construction of the modern battleship—the stern frame, the stem, the rudder frame and the struts. As the size of the battleship has increased, the design and weight of these various types have changed until to-day some of them present unusual problems and difficulties in molding and casting. In addition, those for other navies are usually different. For merchant ships the steel castings are radically different in design and weight, but not so difficult usually to produce, though there are exceptions. The latest battleships, such as the *Arizona, Mississippi* and *California,* require about 343 gross tons of steel castings; the earlier type, as the *Kentucky,* only 123 tons—a decided expansion.

* From the *Iron Age.*



Large Stern Frame for Merchant Ship



Bow Casting for U. S. S. *Idaho*



Rudder Frame for U. S. S. *Pennsylvania*



Stern Frame



Cast Steel Rudders for Merchant Vessel

The molding and casting of a battleship stern frame, or even stem, are undertakings requiring much time, care and patience. The mold for the stern frame is often made in several parts, and is always baked thoroughly in an oven. The various parts are molded in flasks which are carefully joined together, usually in a casting pit of large dimensions. The completed mold is often as large as a small-sized house. It is usually necessary to pour such castings with two ladles, one delivering metal at each end of the mold or one supplementing the other. This is necessary not so much because of the weight of the casting itself as because of the length and the fact that the metal must travel a considerable distance and fill up a comparatively thin space. The stem and rudder frame are usually made as one casting, but the stern frame as two, though a few years ago it was poured in one mold.

Grade of Metal Used

The steel for such castings is almost universally acid open-hearth and of the best quality possible. Special care is taken in selecting the charge and in finishing the steel, because the design of a stern post in particular is such that it may easily crack or develop defects that will not pass the very severe United States Government inspection. Until recently all such castings were made of mild steel hving a carbon content of 0.25 to 0.30 percent, with a tensile strength of 60,000 to 70,000 pounds per square inch. But in recent years the tendency has been to make a stern frame or stem lighter in weight, and therefore the metal now prescribed is 0.40 percent carbon steel with a minimum strength of 80,000 pounds per square inch. The chemical requirements otherwise call for manganese, 0.60 to 0.70 percent; silicon, 0.25 to 0.30 percent; sulphur and phosphorus not over 0.05 and 0.06 percent, respectively. In the case of the higher tensile strength metal an elastic limit of not less than 45 percent of the tensile strength is required, a minimum elongation of 17 percent in 2 inches, and a minimum reduction of area of 20 percent. In the case of the mild steel an elastic limt of not less than 45 percent of the registered tensile strength is demanded, as well as a minimum elongation in 2 inches of 22 percent and a minimum reduction of area of 25 percent—not a difficult specification to meet where foundry and furnace practice is progressive. In any case the steel must be very hot and uniform, the two heats which are tapped simultaneously being as near alike chemically as possible.

The pouring itself is not a simple proposition. In casting 25 tons from each of two ladles into one mold extreme care and skill are necessary, because an accident of any kind is expensive. The loss of the entire casting by a break-out of metal from the mold has occurred more than once with spectacular results. When it is considered that the molding of such a casting takes often two months and more and the metal consumed often as much as 35 to 40 tons, the financial loss is a large one.

The cleaning of such a casting is an expensive undertaking. After it has remained in the flask ten days to two weeks it is removed to the cleaning department, where sink heads, often equal in weight to the weight of the casting, are removed.

The annealing must be thorough. It is a difficult process, requiring a large and efficient annealer. Satisfactory heat treatment always involves slow heating to a temperature above the recalescence point and then slow cooling in the closed annealer. The structure thus obtained is always pearlitic. While a sorbitic structure, resulting from quick cooling, would greatly improve the static properties of the metal, the consequent internal strains and warping of the casting would be serious.

Besides the four types of large castings for battleships, many important and by no means small steel castings are

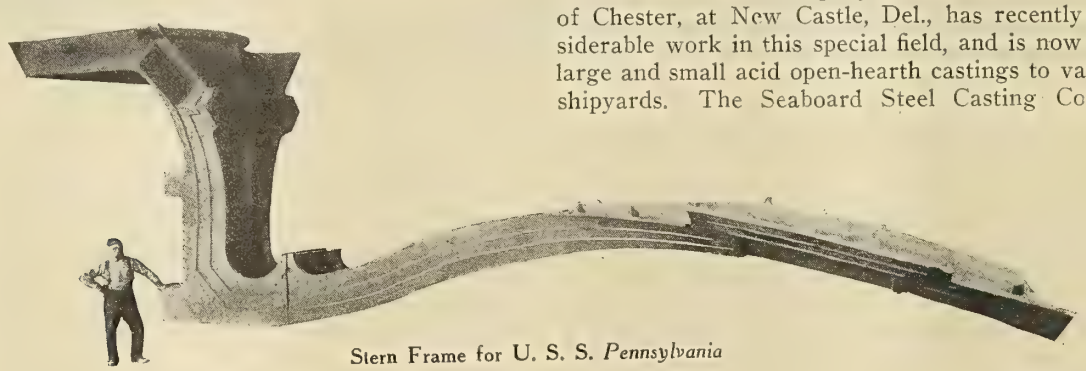


Stern Frame for Argentine Battleship

required in the construction of a modern battleship. The turbine driven ship has developed the need of a cast steel turbine wheel, very large and intricate, calling forth the ingenuity of Chester's skilled labor. In addition there are many important hull and engine castings, such as hawse pipes, bed plates, pistons, etc., each requiring annealing, physical tests and exacting surface inspection by the Government before acceptance. The development of the large gun turrets has called for large turret roller castings, made in segments of a circle and of high carbon steel. For the large 14-inch navy guns an important yoke casting of nickel steel is now made in Chester which was formerly a forging.

The Large Foundries Making Ship Castings

Three large Chester steel foundries now specialize in battleship castings. Two of these have been the pioneers in this work since the new modern United States navy was started late in the 1890's. They all constitute a group different from any other foundries in this country



Stern Frame for U. S. S. *Pennsylvania*

as being the only ones where such work is successfully and continually done. The pioneers in this class of work were the American Steel Casting Company, since 1902 the Chester plant of the American Steel Foundries, and the Penn Steel Castings & Machine Company.

The third foundry of prominence which has specialized in these castings is the Federal Steel Foundry of Chester. It is owned by the Cramp Ship & Engine Building Company, but it also produces castings for other shipyards. At present it is furnishing important castings for the battleship *Idaho,* being built by the New York Shipbuilding Company, Camden, N. J.

This foundry has not been long in existence, and it differs in its product in one important particular. It makes its steel in a basic open hearth furnace, but it uses high grade scrap, such as is used in acid open hearth furnaces, and it pours the same kind of castings as made by the acid foundries.

A metallurgical advantage claimed is that the steel is better than regular basic steel in that less refining is necessary because starting with purer stock; that a better and tougher steel than from the acid furnace using the same stock is obtained; that it is cheaper, and that it is lower in both phosphorus and sulphur than the acid metal and less liable to be defective when cast.

The character of the annealed metal produced by this foundry is indicated by the composition and physical properties of this casting, which are as follows:

Carbon, 0.35 percent; manganese, 0.68 percent; silicon, 0.338 percent; sulphur, 0.041 percent, and phosphorus, 0.025 percent.

Tensile strength, 83,750 pounds per square inch; elastic limit, 43,750 pounds per square inch; elongation in 2 inches, 24 percent; reduction of area, 37.9 percent; cold bend of 1 inch by 0.5 inch bar, 140 degrees.

It will be noticed that the 80,000 minimum tensile strength specified by the Government for this casting has been met, not by aiming at 0.40 percent carbon, but by using a lower carbon and a higher manganese metal—a practice which insures a strong and tough metal.

It is contended that this exceptional furnace practice is the cause of success. It is at least true that it has been generally accepted that castings requiring final machining nearly all over could only be made successfully from acid open-hearth steel.

While the output of this company is not as large as that of the two others—about 800 tons of finished castings per month as compared with 1,800 to 2,000 tons—it has produced and is producing now nearly as large and difficult castings as those already mentioned for both United States navy and merchant ships.

Other Foundries of the District

The Baldt Steel Company, located about 20 miles south of Chester, at New Castle, Del., has recently done considerable work in this special field, and is now furnishing large and small acid open-hearth castings to various large shipyards. The Seaboard Steel Casting Company, of Chester, a large open-hearth plant, in its early history made a considerable number of Government and merchant castings similar to those described, but reecntly has confined its efforts more especially to other lines of work. For every battleship there are a great many small steel castings, nearly all of which the large foundries used to produce, but in recent years these have been made by the smaller foundries. Conspicuous among these is another Chester foundry, the Eagan-Rogers Steel & Iron Company, which has a large output of converter castings.

Before the advent of steel castings for such parts as stern frames and stems these were made of wrought iron. In fact, to-day this metal enters quite extensively into the construction of merchant but not Government work. Many of the earlier wrought-iron forgings for this class of work were made by McPherson & Willard, now the Bordentown Forge & Machine Company, Bordentown, N. J. The Reading Iron Company, Reading, Pa.; the Cleveland City Forge & Iron Company, Cleveland, Ohio, and the Delaney Forge & Iron Company, Buffalo, N. Y., also made these earlier forgings, and the latter company still makes them.

A striking feature of the foregoing development has been the lack of inclination to use anything but plain carbon steels. None of the alloy steels has made any incursion into this field, whereas in locomotive construction vanadium steel castings are widely used.

The future holds out much promise for the increasing importance of these and other foundries in naval and merchant marine development. New foundry problems will arise and new types of castings will be called for, but it need not be doubted that all such demands will be fully met.



Fig. 1.—S. S. *Eurana*, Equipped with De Laval Turbine Reduction Gear

The Steam Turbine on Board Ship

Application of the De Laval High Speed, Double Helical, Speed Reducing Gears to Turbine Drive on Board Ship

IN the last few years the steam turbine has practically displaced the reciprocating engine for large powers on land, for obvious reasons. The steam turbine permits of much larger units than are feasible with reciprocating engines; it reduces the cost of buildings and foundations; it is free from vibration due to heavy reciprocating parts; it shows better steam economy; it is much more reliable and more easily operated than a reciprocating engine, having fewer wearing parts, with a relatively simple lubricating system; it is able to utilize the highest vacuum to good advantage, and the condensate is pure distilled water containing no oil and is, therefore, safe for use in the boilers.

All of these advantages apply with even greater force to steam turbine installations for marine service, but until recently the steam turbine has been used principally in high speed vessels, usually of large size, and in most cases the turbines were directly connected to the propeller shaft.

Owing to the wide difference between the turbine speed necessary for the highest efficiency and the proper propeller speed, direct connection of steam turbines to propellers requires a compromise speed which is not suitable for either the turbine or the propeller.

For slow-speed, cargo-carrying boats, where the propeller speed in most cases does not exceed 125 revolu-

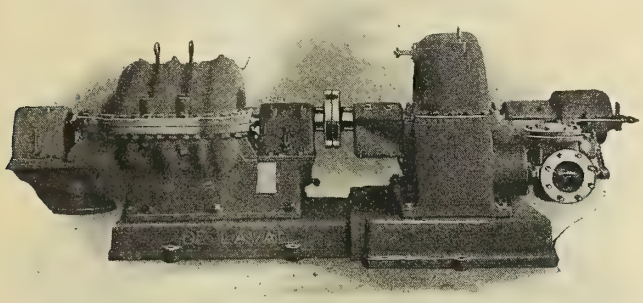


Fig. 2.—De Laval Three-Stage Centrifugal Boiler Feed Pump, Directly Connected to De Laval Velocity-Stage Steam Turbine

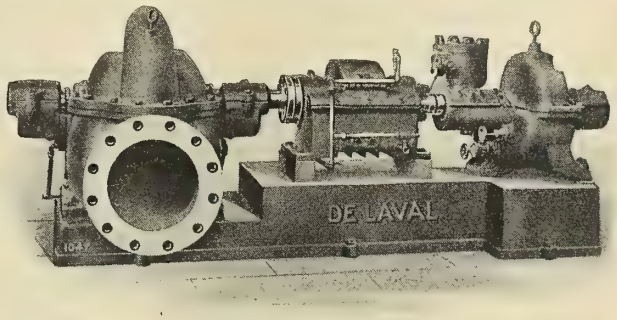


Fig. 3.—Steam Turbine Driven Centrifugal Pump for Circulating Condenser Water; 5,500 Gallons per Minute Against 25-Foot Total Head

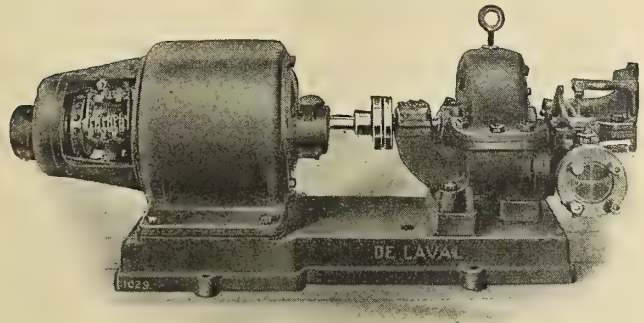


Fig. 4.—Small Auxiliary Lighting Set, Consisting of Direct-Current Generator Driven by Velocity-Stage Turbine; 10 Kilowatt at 3,600 Revolutions per Minute

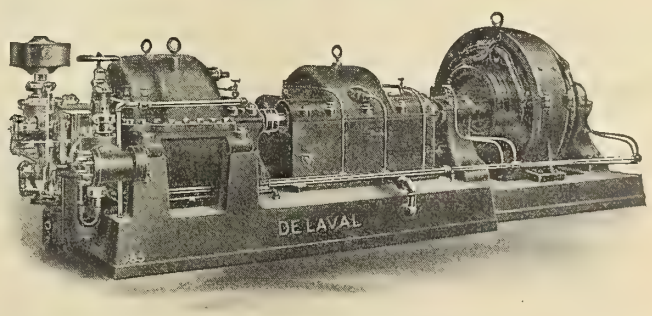


Fig. 5.—De Laval Geared Steam Turbine Driving D. C. Generator on U. S. Battleship *Arizona;* 300 Kilowatt

tions, it is obvious that direct connection of the turbines to the propeller would be impracticable. The logical solution, therefore, is to interpose speed reducing gears between the turbine and the propeller, which will permit both the turbine and the propeller to run at their most efficient speeds. The introduction of reduction gears greatly reduces the weight and size of the turbine and permits of its being designed for the highest efficiency, while the losses in the gear are negligible. The greater simplicity of this type of propelling unit, as compared

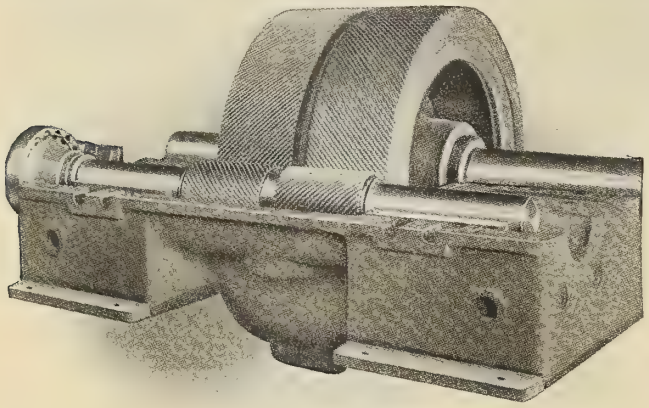


Fig. 6.—De Laval Double-Helical Speed-Reducing Gear, With Casing Cover Removed, Showing Fixed Invariable Supports for Both Gear Shaft and Pinion Shaft

with the reciprocating engine, greatly reduces the expense of maintenance and gives a much higher overall efficiency than is attainable with the reciprocating engine.

Great flexibility of design is also possible, depending on the requirements of the installation, it being possible to design the turbine for moderate capacities in either one or two casings per propeller. By installing two turbines —one a high pressure turbine and the other a low pressure turbine, each turbine provided with its own pinion operating on the gear connected to the propeller—a substantial duplication of driving machinery is obtained, since either half of the turbine can be operated independently on boiler steam, if required, and the highest possible efficiency obtained.

The De Laval Steam Turbine Company, of Trenton, New Jersey, which for over twenty-five years has been engaged in the development of high speed double helical, speed reducing gears for steam turbine service, is building a number of large gear reductions for marine service. One outfit under construction consists of two 2,500 horsepower reduction gears to be installed in a twin-screw freighter. Each unit consists of two pinions operating at 2,200 revolutions per minute on one gear running at 110 revolutions per minte. The De Laval Company is also supplying the gears for two 17½-knot, 10,000-ton passenger boats. These vessels are 450 feet long and are twin-screw vessels, each screw requiring 4,500 horsepower. The gear reduction for each propeller consists of two pinions operating on a main gear, the pinions running at 1,500 revolutions per minute and the gear and propeller at 120 revolutions per minute. For each reduction, one pinion is operated by a high-pressure turbine and the second pinion by a low-pressure turbine.

Four De Laval gear reductions are being supplied for two destroyers for a foreign navy, each reduction being designed for 5,500 horsepower, at a turbine speed of 3,600 revolutions per minute and propeller speed of 450 revolutions per minute. Two 9,500 horsepower gear reductions are being built for a destroyer under construction for the United States Navy.

An essential feature of the De Laval reduction gear is the use of gears and pinions rigidly supported in the casing. This construction is necessary, as any resiliency or flexibilty between gear and pinion results in unequal pressure and wear, and the proper and only effective means of insuring smooth, quiet running and long life are the use of the proper methods for producing the correct pitch, tooth angles and tooth contour. To this end the De Laval Steam Turbine Company has developed special designs of gear cutting apparatus and methods of cutting, and claims that the success being obtained in the daily service by the many large gear reductions of their manufacture in all classes of service proves the correctness of their design. If rigidly supported, gear teeth which have been correctly formed in the first place proportioned to give moderate tooth pressure will retain their orignal correct contours and will operate noiselessly, efficiently and without vibration at the speeds necessary for steam turbine-geared service.

The De Laval double helical gears are cut upon special machines designed and built by the De Laval Steam Turbine Company for the purpose. After cutting, each gear is tested for correct angle, correct shape of teeth and correct pitch, and no gear is used which does not have a perfect contact surface for the whole length of every tooth. No scraping or hand work is permitted on the tooth surfaces, since such hand work produces imperfect contours; and after cutting, the gear teeth are carefully polished by special processes to eliminate the small in-

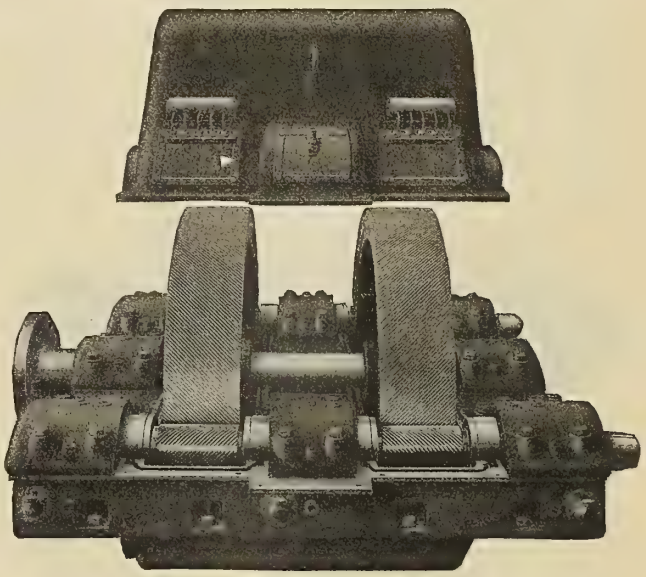


Fig. 7.—De Laval 4,500-Horsepower Marine Reduction Gears

equalities left by the cutting tools, without in the least degree altering the profile of the teeth.

The gear teeth are cut upon seamless rolled steel bands shrunk upon either a cast-iron or cast-steel center, as conditions may require. The gear bands are of special steel, heat treated. The pinions are cut directly on the pinion shaft, which is a special chrome-nickel steel forging, oil-tempered to have a hardness much greater than that of the gear bands, in order to provide different qualities of metals in contact and to insure long life of the pinion. The entire gear, after assembly, is carefully tested for static and running balance.

(*Continued on page* 346.)

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Should the Hydrostatic Test Pressure of One and One-Half Times the Working Pressure be Applied to Marine Steam Boilers Annually?

After an experience of thirty-seven years of service on the Great Lakes, I am of the firm opinion that a hydrostatic test applied to boilers annually at a pressure not exceeding one and one-half times the steam pressure and at a temperature not exceeding 100 degrees Fahrenheit does not injure the boilers as constructed for the lake trade. I have never known nor heard among my acquaintances, extending from Buffalo to Duluth and Chicago, of any injury being done to either boilers or fittings. In regard to the advisability of applying the hydrostatic pressure for the purpose of ascertaining the defects and weaknesses of the boiler, I would say that this test alone will not bring about the desired result.

As a rule, the owner of the boilers does not seem to realize the necessity of having his boilers in readiness for this annual inspection. I have in mind a manager of a fleet of small steamers who viewed the annual inspection with much worriment. Invariably staybolts would be broken, sheets sprung, and a delay of a week or two, or a month, to one or more of his steamers would occur. After he had been advised to see his boilers were in proper condition, that all broken and defective staybolts should be renewed so that when the hydrostatic pressure would be applied no undue strain would be thrown upon the sheets and adjoining braces and staybolts, his troubles disappeared. His method of procedure now is to have a boiler maker go through the boilers every washout day. Any defects are immediately repaired and for the last four years none of his steamers has been delayed on account of the annual inspection. His worriment has also ceased, and he is now of the firm opinion that the hydrostatic test is a good one. It has a corrective influence upon him and his employees and they now know that no excuse will be accepted for any defect found in the annual inspection.

As before stated, the hydrostatic test alone is possibly only thirty to forty percent of the required inspection of the boiler. The examination of the interior of the boiler to determine its cleanliness and the condition of deterioration by disinterested parties to determine its safety is the other remaining percent. The boiler should be washed clean and all soot removed from tubes, sheets and furnaces and no delay should occur other than the time necessary to wash out the loose mud and the soot from the tubes. This interior examination again calls the attention to the owner to the necessity of having the repairs needed to keep his boiler in a safe condition done at a time most convenient to himself and in advance of the annual inspection. In other words this delay to the steamer which is the cause of so much complaint can be avoided by the owner himself taking the proper precautions. The writer can see no reason why the steamboat should be delayed other than the actual time required to make the inspection, if the owner of the steamer will take ordinary precaution to see that his boilers are in safe working condition at all times. The complaint made by many parties regarding the disastrous results to valves and fittings, joints and piping, caused by the application of the hydrostatic pressure test annually is not well founded and can only come through inattention on the part of the engineer in charge or the desire of the management to economize to the point of danger. It is the firm belief of the writer that any main stop valve, auxiliary stop valve, slip joint, throttle valve or line of pipe or flanges connecting same, that would show a weakness or excessive distortion upon the application of one and one-half its working steam pressure should be condemned from further use by the management of the steamer themselves.

A boiler can be severely injured after applying the hydrostatic test or filling the boiler with fresh water after cleaning out by getting steam up too rapidly without the proper circulation. Circulators should be installed in all boilers to assist in the firing up and getting up of steam. A clear case of haste makes waste.

The idea that a boiler has a pressure of only that shown by the steam gage when in operation is an open question. Authorities have not yet agreed how much reaction comes upon the boiler when the engine is working at regular speed, when suddenly put into full speed astern or being worked at a high rate of speed. Attention is here called to the fact that we have many instances of what is known as the breathing action, particularly noticed in our wrapper sheets and our back connections. Broken screw staybolts have been removed from wrapper sheets and the broken ends found to be as smooth as a diamond. This is only one of many proofs. The opening of the steam valve to the engine twice in every revolution, the sudden withdrawal of steam from the boiler and then the immediate closing of said valve to cut off at from half to three-quarters stroke, allows an interval when no steam is withdrawn from the boiler. The result must be a series of recoils; in an engine turning ninety revolutions per minute this brings over ten thousand shocks per hour. As before stated, authorities do not agree in this matter, but still the subject is worthy of serious attention.

Our Scotch marine boilers on the lakes are now approaching an age of thirty years, during which time they have been in operation a little over half that period, so that it would seem to be a poor time to relax in safeguards. It is, of course, understood that those holes in the ends of staybolts drilled half an inch beyond the thickness of the sheet are a good safeguard and give warning, when the bolt has broken, by the steam escaping through the hole. The law requiring this was put into effect in 1898 and the safety of the boiler depends largely upon these holes being kept free. A bolt may be one-half or two-thirds broken under working conditions, and at the time of the hydrostatic pressure being applied the remaining portion will break and warning be given

by said tell-tale hole. The hydrostatic pressure can be immediately stopped and the proper repairs made before applying the full hydrostatic pressure.

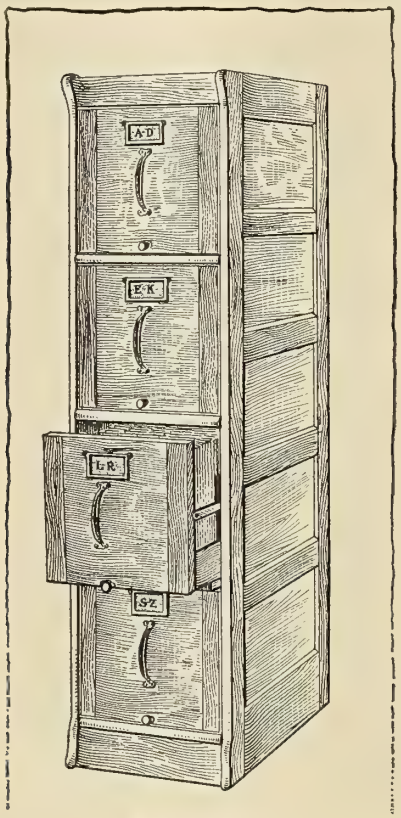
To those boilers that were built before 1898 the hydrostatic pressure still more strongly applies and the hammer test of these bolts that have no tell-tale holes in them can more properly be carried out by having a hydrostatic pressure of about the working pressure. This pressure pulls the sheet away at the point of the broken staybolt and the hammer test can then positively determine if the bolts are broken.

In conclusion, the writer can see no objection to, and most heartily recommends, this pressure test. In the building up of the inspection work from the condition in which it was some years ago, much complaint has arisen. The past ten years have been largely educational to the owner and he has been taught by the delays to his steamer that it amply repays him to have his equipment in proper condition at the time of inspection.

YE OLD CHIEF.

Data Filing System

In response to your suggestion of a few issues ago, I submit the following brief outline of a filing system which I developed and have used for some years. I lay no claims to either consistency or logical arrangement but



Filing Cabinet

simply give it as one which has gradually been built up to suit my needs and one which serves my purpose well.

It is used primarily as a means of filing clippings from the engineering press, abstracts from the proceedings of the various engineering societies, reports, personal computations, photographs, etc., but actually, in practice, it is omnivorous. This very feature of being able to take articles from publications which differ widely in size of page, character of paper, etc., made it highly desirable to have some form of envelope or container for the groups of clippings which should have a uniform exterior yet be able to take all forms of data. The best medium was found to be simple manilla folders, cap size (9½ inches by 15 inches when folded), envelopes proving inconvenient of access. In these folders are placed the data and the upper left-hand corner labeled with the letters for identification in accordance with the system to be enumerated later. The folders are then filed vertically in one of the standard forms of transfer cabinet used for office correspondence (see sketch) and are divided by cardboard tab cards with the legends of the subdivisions and their letter abbreviations in the left-hand corner.

The system of subdivision is a double literal one, the first letter indicating the major division and the second giving the sub-divison. To facilitate memorizing, the divisions and subdivisions have been indicated by letters the same as the initial letters of the subject in so far as possible. In some cases a further subdivision is used and indicated by three letters. In the following are only those divisions which have data actually filed in them, the intermediate letters being available for future expansion.

There is no indexing of the individual articles; but there is a card index of the system, so that if I want a subject I can find the letters representing it and at once go to the cabinet and pick out the folder which has all the data on that subject.

MAJOR HEADINGS

A—Administration.
B—Materials of Construction.
C—History.
D—Resistance and Propulsion.
E—Educational.
G—General Description.
H—Hull.
I—Instruments and Tools.
L—Life Saving.
M—Machinery.
P—Propellers.
R—Research.
S—Shipyards.
W—Wrecks.
X—Aeronautical.
Y—Yachts.

TYPICAL SUB-HEADINGS

A-C—Contracts
A-H—History
A-O—Operation
Etc.

A-O-C—Costs
A-O-L—Ship Lines
A-O-T—Terminals
Etc.

B-T—Testing
Etc.

D-T—Towing Tanks
Etc.

E-A—Apparatus
E-E—Examinations
E-H—History.
E-O—Operation

E-P—Problems
E-R—Description
E-T—Theory
Etc.

H-C—Construction
H-D—Design
H-E—Equipment
H-M—Maintenance
H-S—Specifications
H-T—Theory

H-C-B—Bulkheads
H-C-C—Costs
H-C-D—Decks
H-C-F—Framing
Etc.

G-A—Sailing Ships (Auxiliary)
G-B—Barges

G-C—Channel
G-D—Dredgers
Etc.

I-C—Construction
I-D—Design
I-H—History
I-O—Operation
I-R—Description
I-T—Theory

I-O-H—Horsepower
I-O-M—Mathematical
Etc.
I-R-F—Furnace and Flue
I-R-H—Horsepower
Etc.

M-A—Auxiliary
M-B—Boilers
M-D—Design

M-A-A—Air Compressors
M-A-B—Blowers
M-A-C—Condensers
Etc.

M-E—Engines
M-B-C—Construction

M-G—General	M-B-D—Design
M-H—History	Etc.
M-L—Lubrication	M-E-B—Balancing
M-R—Reduction Gear	M-E-C—Construction
M-S—Specifications	Etc.
M-T—Turbines	M-T-C—Construction
M-W—Weights	M-T-D—Design
	Etc.
P-C—Construction	R-E—Experimental
P-D—Design	R-H—History
Etc.	Etc.
S-C—Cranes	S-C-C—Cranes
S-D—Docks	S-C-D—Docks
S-H—History	Etc.
S-O—Operation	S-D-R—Drafting Room
S-R—Description	Etc.
	S-D-T—Tools
	Etc.
	S-O-A—Accidents
	S-O-L—Launching
	Etc.
W-H—History	X-D—Aero Design
W-R—Description	X-W—Aero Wind Tunnels
W-S—Salvage	
W-T—Theory	
Y-C—Construction	Y-C-C—Cruising
Y-D—Design	Y-C-H—Houseboats
Y-E—Equipment	Etc.
Y-H—History	Y-D-G—General
Y-M—Machinery	Y-D-M—Motor Boats
Y-O—Operation	Etc.
Y-R—Description	Y-E-R—Racing
Y-S—Specifications	Y-E-S—Sails
Y-T—Theory	Etc.
	Y-M-M—Motor Boat Engines

The above list simply represents a few typical groups of sub-headings, and of course in practice this list is expanded to include all subjects pertaining to marine engineering and shipbuilding. ENGINEER.

Lubricating Bearings

In this article it is not proposed to deal with the lubricant itself but with the bearings in which the lubricant is used and the means or methods of getting the lubricant to the bearings.

The general theory of lubricants is that in their use a film of oil or grease is interposed between a moving member and a stationary one. This, I believe, is just one-third of the real facts. Some rather crude experiments convince me that there are, broadly speaking, three films of oil, one which clings to the moving member with more or less tenacity, a second film which clings more persistently to the stationary member, and a third, or neutral, acting between these two. All of these films partake of motion and their speed is never the same. Sometimes unusual and inexplicable action is found in lubricants, but when conditions are carefully considered an explanation is sure to be found, and the mystery so often attributed to the uneven action of oils can be explained. The following is a case in point:

The bearing of a machine gave trouble. It was about 8 inches long and carried a steel shaft about 5 inches in diameter. The bearing itself was of composition of unknown mixture and the work it had to do was quite severe. In order to keep it going without overheating the bearing had to be scraped and touched up about twice a month. After such treatment on one occasion the bearing ran cool for over a month. No change in lubricant had been made and the gain was attributed to a new hand who had done the scraping having been more particular with the work, but the same man touched up the bearing again and to everybody's disappointment no gain over the usual conditions resulted.

Investigation finally proved that this was the cause of the longer run; the new hand, the first time he scraped the bearing, smeared the surface of the shaft with Prussian blue, as is quite usual. In his haste to get the machine going he did not wash off this Prussian blue, consequently this surface evidently had a tendency to hold the lubricant and this prevented the oil from running out as easily as it had done before and formed a better clinging surface than did the steel itself. Whether this is the exact reason may be questioned, but several trials proved that when the Prussian blue was left on the shaft the running condition of the bearing was maintained for a longer time than when the Prussian blue was carefully removed.

Originally the lubricant was applied directly to a bearing and gravity and viscosity did the work. Little care was taken to protect the oil opening from dirt and dust, and with the slow moving machinery of the past the demand for improvement in this matter of cleanliness was slow in coming. Oil cups with covers then made their appearance; and these being tight, a step in advance in lubrication was made. The lubricant, however, in the early forms of application could not be seen and the sight feed oil cup marked another great advance, as while a drop feed had been used in certain positions in engines and other machines the drops were not under control and were often so placed that the wind blew the drops in all directions. The sight feed cup made it possible to see that the oil started for the bearing but it did not insure its arrival, and here is the great advantage of what is known as the forced system of lubrication now being almost universally adopted.

This forced system of lubrication cannot be traced to its origin as far as I have been able to find out. A gentleman by the name of Girdwood, a Scotch engineer, told me as far back as 1876 of having applied it in a Tange engine, which he designed, and which was, according to his statement, the first overhung cylinder engine ever built. He described the system which he applied as a tank hung from the ceiling at a height which gave a pressure of about four pounds to the main bearings and guides, but the crank brasses were lubricated by a wiper cup.

The next engine that I heard of which was fitted with a system of forced lubrication was built in Essen not far from the date given and was the first time that I ever heard of where all bearings were under pressure. Neither of these systems or engines did I personally see, but later I saw a number of engines fitted with the Essen system (if it may be called so properly), and I fitted a number, supplying them to the United States Navy for blowers with the same system which eventually proved perfectly satisfactory. It may be described as follows:

The crank shaft is drilled out so as to allow the oil to pass through the center up through drilled holes in the crank cheeks to the crank pin outlets, from the central drilling or oil passage to the main bearings. Outlets are provided, the hole in the crank pin providing means to lubricate the pin and a surplus of oil is forced down the connecting rod to the crosshead pin and guides. If the engine was double the oil passages were continued on through the crank shaft to other bearings. This, of course, demanded an absolutely closed engine in order to preserve the oil which was copiously provided by means of a single acting pump directly connected to the engine.

This system has failed in quite a number of cases, known to me, the failures being generally attributed to the fact that as the oil is forced along through the oil passages, should the first bearing encountered be loose, the oil finds its way out so easily that the pressure is reduced on sub-

sequent bearings, resulting in an insufficient supply of oil. While it is a self-evident fact that the conditions noted would cause trouble, a little care on the part of those running the engines will overcome the objection and good results will be obtained. There is, however, another way of overcoming the difficulty and that is to grade the sides of the oil ducts in the shafts, beginning by making them as large in diameter as possible and reducing them in area as they are carried on. Not giving attention to this varying of size has often given trouble in forced lubricating systems.

The real objection to this system is that it is not possible to see or feel if the lubrication is being completed, and the passages are extremely difficult to clean; in fact, cannot be cleaned without entirely dismantling the moving parts of the engine. Again, this system demands somewhat higher pressures than other systems.

A second system of forced lubrication may be termed a trunk line system. Here the oil is pumped into a large tube from which branches are led to the various parts requiring lubrication. This system, if it is properly applied, is more satisfactory than the one previously referred to because it has the very great advantage of allowing either a visual or a touch system to be employed, either of which will indicate whether or not the oil has reached its destination. And further, by the use of tees instead of elbows, and crosses in the main line the oil duct can be cleaned by blowing out by steam or swabbed out by waste and wires.

In any system of forced lubrication the fundamental idea is to force a large quantity of oil to the bearings, reclaim this oil and use it again. Before oil can be reused, under these conditions, it should be strained, cooled and allowed to subside; and the subsiding is of great importance, as no system of straining that I have ever seen will remove the very small particles of dirt as does the subsiding tank, and this subsiding must be given time.

I have referred to sight feed cups, and they, on a gravity feed system, are admirable, but when it comes to a forced system of lubrication glass openings, in my experience, soon become opaque and useless. In their place I devised and used methods by which the flow of the oil could be felt, but let me say that I have always preferred a single acting pump in connection with feeding oil, as it is the pulsation resulting from it which allows one to feel whether the oil is flowing in the tube or not. The simplest form of "feel" indication is to file the tube sufficiently thin in one part to have the stroke of the pump felt through this thin wall, and it is easy to conceive without further explanation how this system can be applied almost anywhere.

No matter how the oil is supplied to the bearings the point of entrance for the lubricant is worthy of study, and usually it is not in its proper position. It should be remembered that oil has no idea or desire to be accommodating. It is lazy and will take the easiest means possible to escape from fulfilling its mission. It will never work in toward the center of a bearing; it will always work out. It is, therefore, clear that the lubricant should be introduced in the middle of the bearing, but in a reciprocating type of engine or machine this central opening should never supply the oil to the highest point of the shaft or at its lowest point as the up and down stroke of a machine closes the openings, if at the top or bottom, thus preventing the in-flow of oil at the very moment that it is needed. The oil should be introduced, therefore, at a point about midway between the center line of the shaft and its extreme diameter. In a continuous rotating shaft and in one that revolves constantly in the same direction the lubricant should be introduced midway between the center line and the diameter of the shaft, but on the up-coming side, as this is the point above the horizontal center-line of the shaft where there is the least pressure. I have many times seen troublesome journals entirely cured by merely changing the oil supply opening as here suggested.

There seems to be but one danger in the automatic or forced system of lubrication and that is that it works so well that it is apt to be neglected, with the most disastrous results. Yet this can hardly be called the fault of the system. Further, I have heard it objected to because it allows too much leisure to the men on watch. One superintendent on a steamship line assured me that he would rather have his men going around with a squirt can filling oil cups than to be sure that all his bearings were running cool by the use of forced system of lubrication.

W. D. FORBES.

New London, Conn.

The Allen Dense Air Ice Machine

When I took charge of the ice plant here, which consists of an Allen dense air ice machine of three tons capacity, I had had no experience with this make, so I let well enough alone, as the pressure seemed to be right and the machine seemed to be running well. Although the temperatures in the storage were not all that was desired, there was as yet no time to experiment while in tropical waters.

However, within a few days the compressor piston broke. Fortunately a piece of cast iron of proper size was found aboard and a new piston was machined in the ship's machine shop. This metal did not seem as good as the broken one and a piece of steel was secured and another was begun, which was not quite completed when the other broke. This was hurried and soon finished, while all clearances were taken to assure that the piston did not strike, causing it to break. Now as the time was valuable the piston was packed and the machine started again. This was done without the loss of any meats that were in the storage at the time, although the temperature did rise to 34 degrees by the time the machine was started again.

Soon it was noticed that the compressor cylinder was walking and it was remedied by setting down on the holding-down bolts and tapping down the dowels.

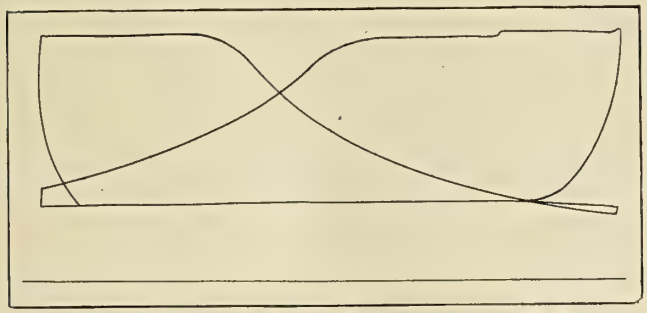
Later a piston rod (compressor) snapped at the base of the threads on the crosshead end. Upon renewal of the rod the machine seemed to be working finely, when within a few days the crosshead broke where the piston rod screwed in and as a spare was on hand it was soon replaced.

Not much later opportunity presented itself to overhaul the entire machine. Upon opening the compressor valve chest it was found that valve seat was scored very badly and as the cylinder had to be removed to machine the seat down for fitting a false seat, just before removing the cylinder a line was run to see if the cylinder was out of alinement. It was found to be out both as to square and not in alinement with the shaft. The exact amount cannot be given, as the figures were lost.

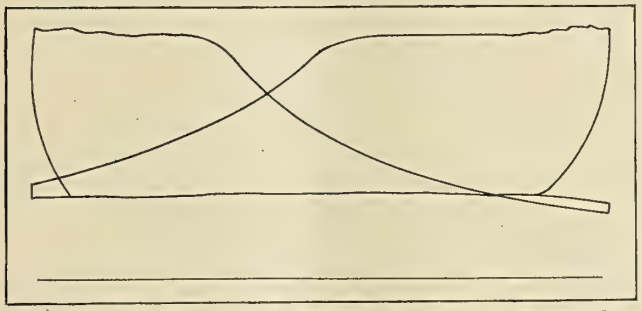
A spare cylinder was installed. This, of course, had been fitted with a false seat. This cylinder was properly alined and secured and the valves were refaced and reset.

The expander cylinder was found to be faulty and a new one was installed. The valves were set by a machinist that had been doing this kind of work for years, and his method was not questioned. When the machine

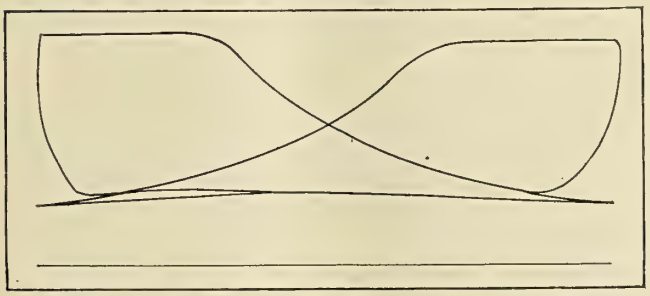
was started, it was found that it did not run steadily, nor did the pressures come right, for the pressure of the compressor would be 250 pounds; but, then, the pressure on the expander would mount to 83 and sometimes to 85 pounds. Now this would not do, for the temperatures would not be low enough in the tropics, so close observations were made, and it was noticed that the leathers would wear very quickly in the expander, and it was first blamed to that. Later as the ship was in cooler weather and the injection water was down to 54 to 64 degrees, time was taken to experiment, as the temperatures of



Card No 1: Compression, 235 Pounds; Exhaust, 72 Pounds



Card No. 2: Compression, 250 Pounds; Exhaust, 80 Pounds



Card No. 3: Compression, 252 Pounds; Exhaust, 64 Pounds

storage were low enough to allow the shutting down of the machine for a few hours.

As the expander pressure was never lower than 81 pounds, even when the leathers were new and the compressor pressure was up to 250, the trouble was to be looked for and found in the expander cut-off valve. The cover was removed and the setting of the valve determined and found to be 5¾ inches on the crank end and on the head end it was 3⅞ inches, which caused it to run erratically. The stroke of the piston was 14 inches.

The machinist was not questioned in regard to the setting of the valves, as he had had years of experience in that line, but it is doubtful if he ever had to run one after he had overhauled it.

The expander valve was taken out and a piece of metal ⅛ inch was fastened to one end of the valve, and this was put in place, splitting the difference in length when setting.

The bonnet was replaced and the machine started, but the result was not as great as was expected, for the expander pressure did not come below 78 pounds, and this was not considered low enough, so other changes had to be made.

Thinking that indicator cards would be a good guide in finding the fault, although the machine was not rigged for taking cards, the following method was adopted in rigging up. An indicator fitting was placed on the drain or blow line of the expander cylinder. A reducing motion was made consisting of a double diameter drum, one having a circumference of 14 inches and the other of 4 inches. This was placed in line with the crosshead of the expander and a small bracket was placed on the crosshead to attach the cord. As there was no means to take the return motion, a spring was attached to the small drum to return the drum on the return stroke of the piston.

All these preparations were made during the times when the machine was shut down, so no time was lost, and when all was ready a set of cards was taken with pressures as given, the compressor 235 pounds and expander 72 pounds, as shown on card No. 1. Card No. 2 was taken at a compressor pressure of 250 pounds and expander pressure at 80 pounds. The revolutions per minute were not taken, nor was any attempt made to find the indicated horsepower, as we were going to find and remedy the trouble first.

Having taken all measurements of the valve, I considered that I would build a valve somewhat longer and install it as time could be found. This valve was made ⅝ inch longer than the one that had been installed. As soon as it was finished it was installed, and again cards were taken, the compressor pressure being 252 pounds and the expander pressure 64 pounds, showing that almost 4 expansions were obtained. This card is marked No. 3. This was considered as being an extraordinary card, as it had perfect lines; in fact, the best card that I have ever seen.

The setting of the valve was done in the following manner: The valve was put on the stem and put in nearly the right position, then the machine was jacked over and cut-off taken at each end. Next it was found that the cut-off, if evenly divided, would take place at 3⅞ inches from each end where it was firmly set and bonnets put on and connections made and the machine started and when the pressures were up to working point, card No. 3 was taken and the results were so good that no further steps were taken to improve it.

The temperatures in the cold storage rooms were found to be lower than formerly and resulted in running the machine only 12 hours a day, as the temperatures were low enough to warrant the shutting down of the machine.

The cold storage rooms are three in number, and are of the following capacity—1,300 cubic feet, 338 cubic feet and 253 cubic feet. The first has a cooling surface of 540 square feet, the second 113 square feet, the third 102 square feet.

The maximum temperature in these rooms has not been over 31 degrees and the minimum temperature has been as low as 14 degrees above zero, that is, the machine has been holding the temperatures down besides freezing over 400 pounds of ice in twelve hours daily.

Full data cannot be furnished till more thermometers are fitted, as then a more careful chart will be made out and the results will be sent in so that the readers of this article will be able to understand the benefit which was derived from the change in valves.

It has now been nearly two months since this change

has been made and the leathers have been renewed only once in the expander and the leathers in the compressor have not been renewed during that time and seem to be in good order, as the compressor pressure is maintained at 252 to 255 pounds at all times. The primer pump is more than ample to make up for the leakage of the valve stems as the relief valve on the primer line would lift every stroke if the stuffing box were set up on so the packing would not leak. The result of having a loose set of packing has made such an improvement that the primer has not been repacked during the last two months and even now is run rather loose.

The cards have not been worked out, as it has not been deemed necessary, for the work that is being done is what we were after.

Another thing that has been done on this machine is that a valve and a check have been placed on the primer line between the compressor intake, so that should the primer pump at any time go wrong the globe valve on the line would be closed and the machine could be run while the primer pump valves were looked at. At one time when an attempt was made to clean the place up a small piece of waste entered into the primer and that time it saved the shutting down of the machine, for if this valve had not been installed the machine would have had to have been shut down while the valve head of the primer pump was off for overhaul.

Now, it must be understood, that all this did not happen in one month as this report covers almost 18 months, but the knowledge gained is worth all the trouble that has been encountered. If any reader has had any better results I would gladly read his experiences.

F. C. W.

The Steam Turbine on Board Ship

(*Continued from page* 340.)

The gear and pinions are lubricated by oil sprays projected against the line of contact of the gear teeth on the entering side. The oiling device can be examined and cleaned conveniently, without lifting the gear case cover or disturbing any of the other parts.

Great care is given to the question of accessibility, as this is of extreme importance in marine work. All gear reductions are designed to be readily accessible in all parts, and all parts entering into the construction are built on a limit-gage, interchangeable basis, insuring perfect fit of spare parts.

The De Laval Steam Turbine Company is also prepared to furnish steam turbines for ship propulsion in any capacity required and to meet any steam conditions. Large numbers of steam turbine-driven auxiliaries have been supplied in the last few months to shipbuilding companies for installation on shipboard, such as turbine and motor-driven centrifugal boiler feed pumps, auxiliary lighting sets and circulating pumps.

In connection with the latter, attention is drawn to the great advantage of using turbine-driven geared circulating pumps, as the reduction gear permits both turbine and pump to operate at their most efficient speeds, resulting in a very high overall efficiency. Fig. 3 shows a turbine-driven circulating pump designed to handle 5,500 gallons per minute against a head of 25 feet; the turbine operating on a steam pressure of 200 pounds and exhausting into a feed water heater against 6 pounds back pressure. These auxiliary units are all of small and compact design and are an ideal type of auxiliary for installation on shipboard.

Where the electric power required is much as on battleships, passenger boats, etc., many advantages are gained by using standard speed direct-current generators, driven by geared steam turbines. Fig. 5 shows a unit of this type, consisting of a De Laval geared turbine driving a 300-kilowatt, direct-current generator. Two units of this type were supplied for the United States battleship *Arizona*. The generator is of the standard slow-speed type, with which all engineers are familiar, and the turbine is designed to run at its most efficient speed, giving a high overall efficiency and a stable, reliable unit, which qualities are not possessed by directly connected, high-speed, direct-current generating sets, particularly in the larger capacities.

Where the auxiliaries are small and few in number, their steam consumption is often more or less immaterial, since all of the auxiliary exhaust can be employed in heating the boiler feed water, thus returning to the boiler all heat represented by the steam consumed by the auxiliaries, except a small portion lost in radiation and converted into power. Where the amount of exhaust is larger, however, it can either be turned into an intermediate stage of the main turbine, or can be exhausted to the condenser. The fact that the exhaust is entirely free from oil gives a turbine-driven unit a marked advantage over the old-style reciprocating auxiliaries, which constitute a continual menace to the boiler by reason of a relatively large oil consumption.

SHIPBUILDING IN ITALY.—During the year 1915 the only steam vessels of importance turned out from Italian shipyards were the *Giuseppe Verdi* of 9,974 gross tons, built at Riva Trigoso by the Esercizio Bacini for the Transatlantica Italiana Company, the *Citta di Tripoli*, of 3,950 gross tons, and the *Citta di Trieste*, of 4,450 gross tons, built by the Cantieri Navali Riuniti, the first at Ancona and the second at Palermo for the Sicilia Company. At the end of the year there were 25 steel steamships under construction in Italian shipyards, aggregating 102,670 gross tons, of which 14 were over 2,000 gross tons each.

SHIPBUILDING IN MAY.—The Bureau of Navigation, Department of Commerce, reports 114 sailing, steam, gas and unrigged vessels of 61,881 gross tons built in the United States and officially numbered during the month of May. Fourteen of these vessels, of 51,656 gross tons, were steel steamships.

NEW YORK AND BOSTON BOATS USING THE CAPE COD CANAL.—Since June 1 the Metropolitan Line steamers *Massachusetts* and *Bunker Hill* have been making their daily trips between New York and Boston through the Cape Cod Canal. Over this route the length of the voyage is shortened by 77 miles and the time by one and a half hours.

SCHOOL FOR TRAINING NAVAL OFFICERS FOR SUBMARINE SERVICE.—A new school for the instruction of naval officers in the theory and practice of submarine operations has been established at New London, Conn., by the Secretary of the Navy. The first class of officers will report July 1 for six months' training before they are assigned to duty on submarine boats.

SHIPBUILDING IN NORWAY.—The two largest shipyards in Stavanger, Norway, completed during 1915 six steamers of 3,100 tons. The output for the whole of Norway in 1915 was 55 steamers of 45,999 tons. Extensive alterations are now under way in the shipyards which will make it possible for vessels of much larger tonnages to be built and repaired.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

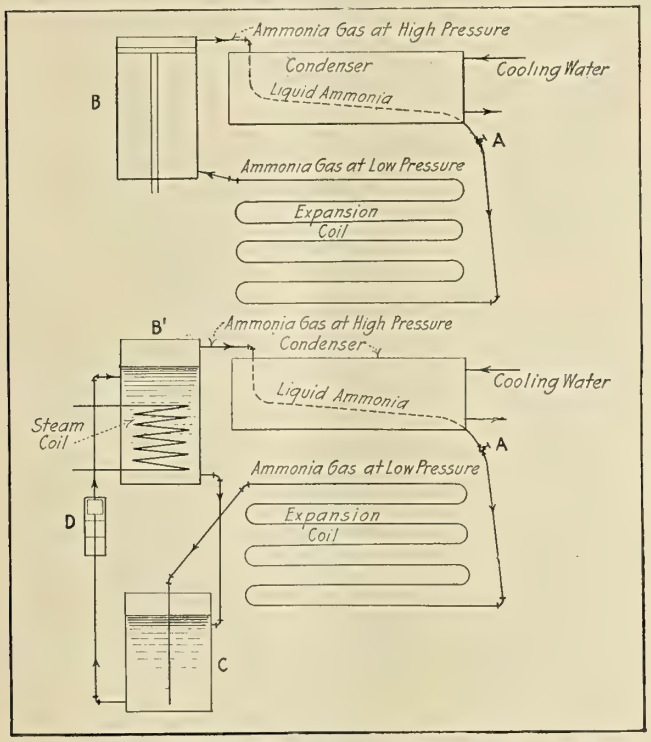
CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, and defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Difference Between Compression and Absorption Ammonia Refrigerating Systems

Q.—Will you please explain to me the difference between a compression and an absorption refrigerating system if both use ammonia? Does the absorption of a gas take up heat the same as evaporation? A. M.

A.—There is no difference in the fundamental principle of both systems. Each derives its refrigerating capability by utilizing the characteristic property of a vapor called heat of vaporization, or latent heat. Each is arranged to produce a vaporization of the liquid into vapor at a place



A, Expansion Valve; B. Compressor; B′ Generator; C, Absorber; D, Pump for Liquid

where the latent heat for this vaporization is absorbed from the space it is desired to cool. Each takes the vapor at a low pressure and temperature and by doing work upon it delivers it at higher pressure and temperature to a condenser, which transforms it into the liquid state, in which condition it passes to the vaporizing chamber. The difference is in the manner in which the work is performed on the ammonia and the method of maintaining the high and low pressures necessary for the liquefaction and evaporation respectively. In the compression machine this pressure difference is maintained by a mechanical unit (the compressor), in the absorption machine the high pressure is supplied by boiling a rich solution of ammonia in water which gives off ammonia gas at high pressure and the low pressure is maintained by absorption of the gas by water in place of the suction of the compressor. The absorption of ammonia by water does not take up heat. On the contrary, it generates heat and the absorption chamber in machines of this type is cooled by water coils. Absorption machines simply minimize the number of moving parts in a compression system and by using the waste heat from other machines as the supply for the steam coils which boil the rich ammonia liquor, then economy is in many cases excellent.

Amount of Material Necessary to Sheath a Boat

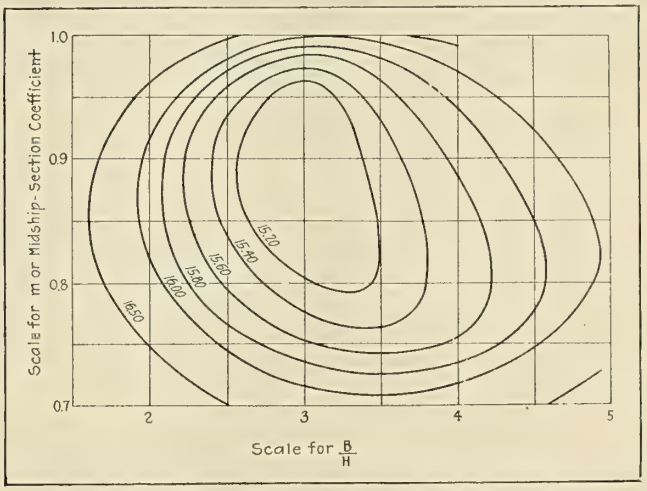
Q.—Can you give us a rule or general information as to how to estimate the number of sheets of yellow metal required to sheath a boat when only length, beam and draft or depth of hold are given?

We have lately had a number of foreign inquiries of this character and there is a wide difference in estimates that have been received as to quantity required. In fact, in some cases it is double the amount estimated in other cases.

We realize that the shape of the bottom of the boat must be allowed for, and therefore the amount required cannot be accurately figured without a drawing, but we wish to quote on enough material so that there will not be a sheet or two short, and at the same time not send a double supply. One inquiry from South America gives us the length of boat as 60 feet, the beam 12 feet, depth of hold 6 feet. We estimate the draft at about 3 feet to 3 feet 6 inches.

Any suggestions as to general rule covering this question will be very much appreciated. SHIPBUILDER.

A.—The best method of determining the amount of material necessary to sheath a boat is to estimate the wetted



Contour Curves of Wetted Surface Coefficient on Midship Section Coefficient and $\frac{B}{H}$

surface and to make such allowance over this as will allow for waste in fitting, overlap of seams, appendages, etc.

Provided the boat has a form that is reasonably ship-shaped, the following formula, due to Naval Constructor D. W. Taylor, U. S. N., and published in his "Speed and Power of Ships," gives the closest estimate of wetted surface. To this must be added the surfaces of the keel, rudder and various appendages, and to the total thus obtained the proper allowance must be made to allow for overlap and wastage.

Wetted surface $= C\sqrt{D \times L}$.

Wetted surface in square feet:

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

D = Displacement in tons (total weight of boat).
L = Length at load waterline in feet.
C = Constant taken from figure accompanying, in which
B = Beam at low waterline in feet.
H = Draft (molded) in feet.

$$m = \text{Midship section coefficient} = \frac{\text{Area Midship}}{B \times H}$$

For the case mentioned, if we assume a block coefficient of .79, the displacement is

$$\frac{60 \times 12 \times 3 \times .79}{35} = 48.8 \text{ tons} = D.$$

Estimating the midship section coefficient to be about .80 = m, we get the value of C from the plot to be

$$15.5 \left(\text{at } m = .80 \text{ and } \frac{B}{H} = 4\right)$$

then

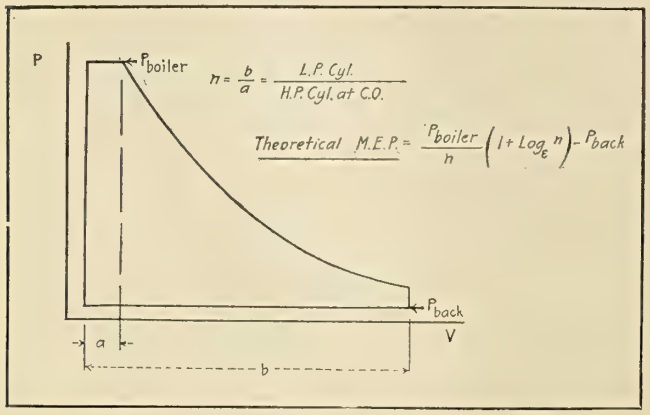
$$\text{Wetted surface} = 15.5 \sqrt{48.8 \times 60} = 839 \text{ square feet}$$

Allowing 20 percent for rudder and appendages, gives a total wetted surface of 858 square feet, which is to be increased by the necessary allowance for wastage and fitting. For rough estimations the value of 15.5 for the constant C covers most cases, though for broad boats and shallow draft boats with sharp bilges a higher value would be preferable, say 16 or 16.5 in extreme cases.

Indicator Cards for Triple Expansion Engine

Q.—A short time ago I was before a local board of steamboat inspectors, taking an examination for an engineer's license, and among other questions was asked to draw a set of cards presumably taken from a triple expansion engine. I was to furnish all the data myself; that is, diameter of cylinders, stroke, steam pressure, etc., and work up the cards to correspond to these data. I should greatly appreciate any suggestion or help you can give me in answering a question of this sort. OILER.

A.—The question is rather indefinite and its exact purpose difficult to conjecture, but probably it was intended to do one of two things: either to test the applicant's



Sketch of Card

memory and sense of the general proportions and characteristics of a triple expansion engine and its diagrams, or it was intended to determine his knowledge of the principles of engine design. For the first, data of any specific installation should be sufficient. If the second were wanted the answer might be as follows:

Assume a boiler pressure, vacuum, piston speed, cylinder ratios, and either revolutions per minute or stroke, then solve for the proper size of cylinders to give the horsepower desired and sketch the cards each with the proper area and mean effective pressure. For example, let us take the design of a three-cylinder, triple expansion engine to develop 1,800 indicated horsepower with a boiler pressure of 180 pounds gage, vacuum of 27 inches (which would give about 4 pounds back pressure in the low pressure cylinder), piston speed of 630 feet per minute and a stroke of 42 inches. Reasonable cylinder ratios would be 7.1 for low pressure to high pressure and 2.8 for intermediate to high pressure and with cut-off at three-quarters stroke. The solution for the low pressure cylinder diameter could be made as follows, and from it the diameters of the others would be found directly from the cylinder ratios assumed.

The expression for indicated horsepower is

$$I.H.P. = \frac{2PLAN}{33{,}000}.$$

Where P is the mean effective pressure referred to the low pressure cylinder,
L is the length of the stroke in inches,
A is the area of the low pressure cylinder,
N is the number of revolutions per minute.

All of these are known except A and P, so if a reasonable value can be estimated for P the area A can be determined at once. For engines of this type about 65 percent of the power that would be developed, if the expansion in the cylinder were hyperbolic, is realized. Hyperbolic expansion for this case would give a *theoretical*

$$M.E.P. = P_{\text{boiler}} \times \frac{1}{n}(1 + \text{Log}_e\, n) - P_{\text{back}}$$

P = pressure in pounds per square inch

$$n = \frac{\text{Vol. L. P. Cyl.}}{\text{Vol. H. P. Cyl. at } C.O.}$$

$n = \frac{7.1}{.75} = 9.48$. *Probable* M. E. P. = .65 × theoret. M.E.P.

$$= .65\left(\frac{194.7}{9.48}(1 + 2.249) - 4.0\right) = 40.8 \text{ pounds per sq. in.}$$

then since

$$2LN = \text{piston speed, } 1800 = \frac{630 \times 40.8 \times A}{33{,}000}.$$

$L.P.A. = 2313$ square inches
$L.P.$ diameter $= 54\frac{1}{4}$ inches.

As the areas are proportional to the squares of the diameters the sizes of the intermediate and high pressure cylinders are determined directly from the assumed cylinder ratios and are

$H.P.A. = \frac{2313}{7.1} = 325$ sq. ins. Diameter $= 20\frac{3}{8}$ ins.

$I.P.A. = 325 \times 2.8 = 901$ sq. ins. Diameter $= 33\frac{7}{8}$ ins.

If the assumption is made that the work is equally distributed between the cylinders, which is not far from true if the cylinder ratios are well chosen, then the proper mean effective pressure and areas for the cards for all cylinders are known and cards sketched in accordance.

Definition of "Inverted" as Applied to Marine Engines

Q.—Can you tell me why it is that in descriptions of modern marine engines they refer to them as "three-cylinder, triple-expansion, vertical, *inverted*, etc."? I can see a reason for all the adjectives except the *inverted*, and must confess that I can see no "rhyme or reason" for that. If you can enlighten me, I shall be much obliged and will pass it along to others who, I know, are in the same fix. L. O. D.

A.—The adjective "inverted" when used in describing the present type of marine engine is superfluous and is simply an historical relic of the days when the walking-beam engine driving side paddle wheels was the common type. This engine had its cylinder in the bottom of the ship with the piston rod, crosshead, etc., above it and when the first engines of the present type driving propellers came out they were called "inverted," a term which has survived even to the present day, though rapidly becoming obsolete.

Shipbuilding and General Marine News

Contracts for New Ships—Marine Terminal Improvements—Recent Launchings—Improved Appliances—Personal Items

Steel merchant vessels building, or under contract to be built, in private American shipyards on June 1, 1916, according to builders' returns to the Bureau of Navigation, Department of Commerce, numbered 372 of 1,147,534 gross tons. The growth during recent months is shown by the following summary of (*a*) vessels building, or under contract to be built, on the first of each month, beginning with February, 1916, (*b*) new contracts during that month, (*c*) vessels completed during that month.

On the 1st of—	Built or Under Contract.		New Contracts.		Vessels Completed.	
	Number	*Gross tons*	*Number*	*Gross tons*	*Number*	*Gross tons*
February	230	901,371	20	61,136	6	31,329
March	244	945,798	107	151,296	5	23,394
April	360	1,067,856	20	51,011	6	12,915
May	368	1,129,014	20	81,470	13	53,840
June	372	1,147,534	....	.....	....	.....
Total	.....	.....	167	344,913	30	121,478

One principal establishment announces that as it is booked to capacity until well into 1918 it does not expect to book any more contracts during 1916. New shipyards just beginning operations furnished most of May's increase.

The demand for shipbuilding plates continues very large, as contracts for new vessels are now under discussion which will require extensive plate and shape tonnages for the last half of 1917 and the early part of 1918. These contracts are to be placed with American shipyards, and confirm the belief that ship construction in this country will increase rather than decrease after the war ends.

Thirty-seven lumber-carrying vessels are under construction, or have been ordered, on the Pacific Coast.

During the past few months contracts for fifteen ships to be built in American yards, valued at about $12,000,000, have been ordered by Hannevig & Johnsen, New York.

Shipbuilding Orders

The Union Iron Works Company, San Francisco, Cal., has received a contract from the Pan-American Petroleum & Transport Company (a new concern which will include the Mexican Petroleum Company, New York, and other oil concerns) to build two oil tank steamers to cost about $2,750,000.

The Union Iron Works Company, San Francisco, Cal., has received a contract from the Huasteca Petroleum Company, New York, to build three more oil tank steamships.

The Fore River Shipbuilding Corporation, Quincy, Mass., has received a contract to build two oil tank steamers for the Huasteca Petroleum Company.

Moore & Scott, San Francisco, Cal., will build one oil tank steamer for the Huasteca Petroleum Company.

The Hanlon Shipbuilding Company, Oakland, Cal., has received an order from Balfour, Guthrie & Company, San Francisco, Cal., to build the largest wooden ship ever constructed on the Pacific Coast. The vessel in question is a five-masted barkentine, and will be 270 feet long.

The Wilmington Iron Works Company, Wilmington, N. C., has received a contract, through Cox & Stevens, naval architects, New York, to build four 220-foot wooden cargo steamers.

Percy & Small, Bath, Me., have received a contract from C. C. Mengel & Bros. Company, Louisville, Ky., to build a second four-masted schooner. This will be a duplicate of the *Charles D. Loveland*, built at the same yard.

It is reported that Capt. W. A. Blake, Baltimore, Md., has placed a contract with a Maine shipyard to build a four-masted wooden schooner.

It is reported that the Submarine Boat Corporation, New York, has received a contract from France covering the construction of ten submarines and 200 speed launches to be built in Canada. The amount of the contract is stated to be $12,700,000.

It is also reported that the Submarine Boat Corporation has a contract with the Italian Government to build six submarines.

Bixby & Clarke, San Francisco, Cal., are stated to have placed a contract with a Pacific Coast shipyard to build a 255-foot wooden steamer.

The Wallace Shipyards, Ltd., North Vancouver, B. C., have received a contract to build three five-masted schooners, 255 feet long, to be equipped with auxiliary oil engines.

Capt. Geo. A. Gilchrist, Belfast, Me., is building a four-masted schooner for George McQuesten Company, East Boston, Mass.

The barge *B. L. Winchell*, belonging to the Gulf Refining Company, New York, is being cut in two by the Johnson Iron Works, New Orleans, La. One-half will be converted into an oil barge at the plant of the Johnson Iron Works; the other half will be towed to the Gulf City Boiler Works at Mobile, Ala., and will also be converted into an oil barge.

C. E. Fulton, Mormon Island, Los Angeles, Cal., is reported to have a contract to build a small steamer.

The Greenport Basin & Construction Company, Greenport, L. I., is building a number of cruisers and high-speed launches, among them being a 39-foot high-speed launch for F. K. Lord, naval architect, New York.

In addition to the large order which the Greenport Basin & Construction Company has executed for the Russian Government, a number of scout cruisers are under construction for a purpose which has not been divulged. The boats are stated to be 52 feet 6 inches long, and to be equipped with two 400-horsepower engines.

It is reported that the Western Dry Dock & Shipbuilding Company, Fort William, Ont., Canada, has received a contract to build two ocean-going freight steamers 251 feet long.

The Hanlon Dry Dock & Shipbuilding Company, Oakland, Cal., is reported to have received a contract to build a fleet of kelp barges for the Hercules Powder Company.

Shipyard News

The American Shipbuilding Company, Cleveland, Ohio, is planning to build a shipyard at Puget Sound which will admit of the construction of fifteen vessels at one time. It is reported that contracts have already been received to build five vessels at the new yard.

The Wm. Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., has purchased 45 acres of land at Petty's Island on the Delaware River, for the purpose of further enlarging its facilities, and will build a large dry dock there.

The officers of the new shipbuilding yard established at Brunswick, Ga., are H. H. Mason, president; J. R. Lee, vice-president and general manager; L. E. Allen, secretary and treasurer. The company is building a 600-ton schooner, and is reported to have booked several more orders.

The newly-organized Sun Shipbuilding Company, Finance Building Philadelphia, Pa., whose yard is at Chester, Pa., has let contracts for a dozen buildings and six shipbuilding berths. The company is reported to have received orders to build several ships and it expects to lay the first keel in September.

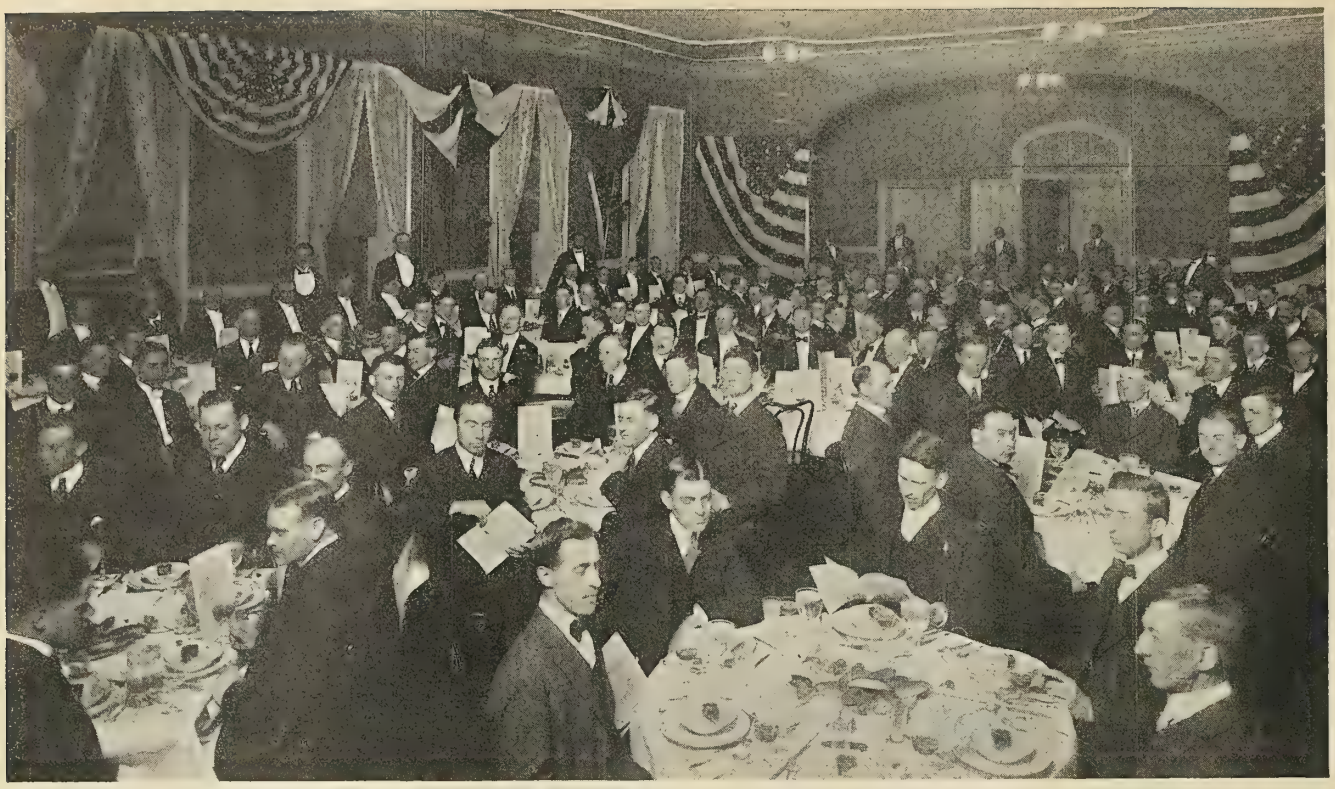
The Coastwise Shipbuilding Company has been organized at Baltimore, Md., by F. A. Brandy, Thomas Whedbee and R. Williams. The company reports that it has already taken orders to build several ships.

The property of the Tietjen & Lang Dry Dock Company, Hoboken, N. J., has been bought by a syndicate headed by Bertron Griscom & Company, New York. The company announces that the property will be managed in future by William H. Todd, president of the Robins Dry Dock & Repair Company, Brooklyn, N. Y.

It is reported that J. H. Thompson, Belfast, Ireland, has interested capitalists with the intention of building a $5,000,000 shipyard in Oakland, Cal.

The Motor Ship Construction Company has been organized at Olympia, Wash., and it is stated that the company has already received contracts to build four lumber schooners.

The San Francisco Bridge Company, San Francisco, Cal.,



Annual Banquet of American Society of Marine Draftsmen at Warwick Hotel, Newport News, Va., April 22

has begun work on the construction of the $2,000,000 dry-dock to be built for the Union Iron Works Company at Hunter's Point. This dock will be able to accommodate ships 1,000 feet long, with 100-foot beam.

It is reported that the plant of Robert Palmer & Son, Noank, Conn., of which the United States Steamship Company, New York, has assumed control, will be equipped for the construction of steam vessels.

The Novia Scotia Steel & Coal Company, New Glasgow, N. S., has begun work on a yard where it is planned to build steel vesels, and is stated to have already received a contract to build a 200-foot steamer.

The Coastwise Shipbuilding Company has purchased a site at the foot of Andre Street, Baltimore, Md., where it is planning to establish a plant to build auxiliary schooners to ply between Baltimore and South America.

The Vancouver Island Marine, Ltd., has been incorporated, with headquarters in Victoria, B. C. Charles J. V. Spratt is at the head of the new company, which is stated to have already received an order to build a four-masted barkentine.

It is reported that a shipbuilding and dry dock company is being organized in Savannah, Ga., with a capitalization of $1,000,000.

The Bulk Oil Transportation Company has been incorporated in Delaware for the purpose of building and operating ships. The incorporators are C. Stewart Lee, Edward Martin and J. Warren Vedder, all of Wilmington.

The Peninsula Shipbuilding Company has been organized at Portland, Ore., by F. C. Knapp, W. M. Ladd, A. L. Mills, A. C. Ainsworth, T. B. Wilcox and Peter Autzen, all of Portland.

New Steamship Companies

A new steamship company, to operate passenger and freight steamers between Boston and New York, has been planned. Albert M. Beers, Newton, Mass., has been appointed manager.

The Lutz Shipping Company has been incorporated, with headquarters at Pensacola, Fla. E. Lutz is president; John A. Merritt, vice-president; R. H. Turner, secretary-treasurer.

The Wilmore Steamship Company has been organized, with a capital of $1,800,000, by John E. & E. J. Berwind, New York.

The Franklin Baker Shipping Company has been incorporated, with a capital stock of $100,000, to engage in the shipbuilding and operating trade. The company has been organized entirely by the Franklin Baker Company, Philadelphia, Pa.

The Vinegar Bend Lumber Company, Mobile, Ala., is planning to operate a barge line between Mobile and Cuba, and orders have already been placed for several ocean-going lumber barges.

The Southland Steamship Company, capital $5,000,000, has been organized at Savannah, Ga., by George P. Walker, Frank D. N. Strachen, George F. Armstrong and others, and is stated to have given the Union Iron Works, San Francisco, Cal., a contract to build a $1,000,000 steamship.

Marine Terminal Improvements

The Chicago, Milwaukee & St. Paul Railway Company, St. Paul, Minn., is improving its ocean terminals at Tacoma, Wash., and is planning to spend $500,000 on the work.

A. Webster, Director of the Department of Wharves, Docks and Ferries, Philadelphia, Pa., has had plans drawn for the construction of several piers. The estimated cost is $4,000,000.

The Canton Company, Commerce and Water streets, Baltimore, Md., is having a 600-foot pier built at Canton, Baltimore, Md.

The Healey-Tibbets Construction Company, San Francisco, Cal., has received a contract to build an addition to Pier 38, San Francisco.

E. L. Gorham, city engineer, Lake Charles, La., has prepared plans for a municipal wharf.

The Wilmington Steamboat Company, Wilmington, Del., has given a contract to William D. Haddock & Company, Wilmington, to build a wharf and shed.

J. F. Duthie & Company, Seattle, Wash., are planning to build a $200,000 dry dock. William T. Donnelly, 17 Battery Place, New York, is the engineer.

George Cromwell, city engineer, Ocean Beach, Cal., is planning the construction of two freight piers.

Dock Commissioner R. A. C. Smith, Pier A, New York, has drawn plans for repairing the pier at the foot of West Fifty-fifth street, North River, and to construct a freight shed and make other improvements.

The city of New Haven, Conn., is planning a bond issue of $250,000 for the extension of the New Haven Public Wharf. Address Charles E. Julin, secretary of the Chamber of Commerce.

The city of Selma, Ala., will build a wharf of stone and concrete construction.

MARINE ARTICLES IN THE ENGINEERING PRESS

Beam and Draft of Warships.—Editorial discussion of a series of experiments carried out in the Washington experimental basin by Rear Admiral D. W. Taylor, showing that in battleships it is not only possible to have a reduced power with increase of beam on account of a finer block cofficient, but that in some cases there may be a gain due to the adoption of a more suitable longitudinal coefficient. 1,200 words.—*The Engineer,* May 12.

An Experimental Tank Reproducing Wave Motion.—By Col. G. Russo, R. I. N. Abstract of paper read before the Institution of Naval Architects on April 12. 6 illustrations. 3,800 words.—*Engineering,* May 12.

The Position of the British Merchant Fleet.—Editorial article urging definite action for maintaining the over-sea carrying capacity of the British merchant fleet. 1,300 words. —*Engineering,* May 12.

U. S. S. Oklahoma.—By Henderson B. Gregory. Detailed description of the battleship *Oklahoma* of 27,500 tons displacement and 20.5 knots designed speed, built by the New York Shipbuilding Company, Camden, N. J., for the United States navy. 3 illustrations. 12,000 words.—*Journal of the American Society of Naval Engineers,* May.

Testing of Metals at the Engineering Experiment Station.—By D. J. McAdam, Jr. Descriptions of methods employed at the Naval Engineering Experiment Station for the metallographic examination and physical testing of metals. 15 illustrations. 2,800 words.—*Journal of the American Society of Naval Engineers,* May.

U. S. S. Conyngham.—By Lieut. H. H. Norton, U. S. N. Detailed description of the torpedo boat destroyer *Conyngham,* of 1,090 tons displacement and 29½ knots speed, built by the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., for the United States navy. 2 illustrations. 4,800 words.—*Journal of the American Society of Naval Engineers,* May.

The Industrial and Strategical Importance of our Naval Stations.—By Rear Admiral John R. Edwards, U. S. N., retired. A discussion of the value of the United States Naval Stations in relation to the maintenance and upkeep of the navy, and a plea for better preparedness in this arm of national defense. 24,000 words.—*Journal of the Society of Naval Engineers,* May.

An Alternating-Current System for Engine Telegraph, Helm-Angle Indicators, Etc.—By Leonard A. Doggett. Description of the two general principles for interior signaling systems on board ship, and suggestions for the development of small instruments to indicate helm-angle and position of turrets and the application of such instruments for searchlight control. 9 illustrations. 2,000 words.—*Journal of the American Society of Naval Engineers,* May.

The Firing and Combustion of Soft Coal Under Naval Boilers.—By William L. De Baufre. Information based on experience in testing coals by burning fuel on navy standard grates under navy boilers at the United States Naval Engineering Experiment Station. Recommendations for obtaining the most economical results from combustion under these conditions. 1 illustration. 4,500 words.—*Journal of the American Society of Naval Engineers,* May.

The Fractional Distillation of Lubricating Oils.—By J. G. O'Neil. Description and results of an investigation made to devise a fractional distillation method for separating a mineral oil into its component light oils, intermediate oils and heavy oils, and to investigate the properties of these light, medium and heavy oils. 7 illustrations. 7,200 words.—*Journal of the American Society of Naval Engineers,* May.

Submarine Engines of the German Navy.—By Lieut. C. W. Nimitz, U. S. N. Description of the Augsburg, Nuremberg and Krupp (two-cycle) types of Diesel engines. 4 illustrations.—4,200 words.—*Journal of the American Society of Naval Engineers,* May.

U. S. S. Jacob Jones.—By W. F. Sicard. Detailed description of torpedo boat destroyer *Jacob Jones,* of 1,090 tons displacement and 29½ knots' speed, built by the New York Shipbuilding Company, Camden, N. J., for the United States navy. 2 illustrations. 6,800 words.—*Journal of the American Society of Naval Engineers,* May.

Analysis of Stresses in Connecting Rods.—By Lieut. Karl F. Smith, U. S. N. Mathematical discussion showing that the stresses deduced by the formulæ for connecting rods now in general use are misleading, and give results much below the actual stresses in the rod. 7 illustrations. 5,000 words.—*Journal of the American Society of Naval Engineers,* May.

Lighterage.—By Henry L. Joyce, manager, Marine Department, Central Railroad of New Jersey. Paper read before the New York Railroad Club on May 19, showing the development of the present great lighterage system operated in New York harbor. Brief description of the barges, carfloats, hoisting derricks, grain elevators, etc., used in this service. 4,000 words.—*Transactions of the New York Railroad Club,* 1916.

The Ljunström Turbine and Its Application to Marine Propulsion.—By Roland S. Portham. Paper describing the development of electric propulsion, with detailed description of the Ljunström turbine and its application with electricity and mechanical reduction gears to the propulsion of vessels. 25 illustrations. 8,000 words.—*Transactions of the Institution of Engineers and Shipbuilders in Scotland,* April.

Shaft Calibration.—By William H. Carter. Description of calibrating device, torsion indicator and calibrating test for determining the relation existing between the angle of twist and the horsepower transmitted by a shaft. Formulæ and results deduced. 1 table. 4 illustrations. 2,500 words.—*The Journal of the American Society of Marine Draftsmen,* April.

The Merchant Marine.—By Capt. William G. Randle. General review of the past success, the present condition and the future prospects of the shipping interests of the United States in comparison with those of the other nations of the world, with a plea for the application of a portion of the nation's wealth to the building of a navy and to the advancement of the interests of a great mercantile fleet. 3,000 words.—*The Journal of the American Society of Marine Draftsmen,* April.

Marine Steam Turbine Machinery.—By E. H. B. Anderson. Critical discussion of several papers read before the International Engineering Congress at San Francisco in 1915, with comparisons of reciprocating engine, turbo-electric and geared turbine systems of propulsion. 2 illustrations. 3,500 words.—*The Journal of the American Society of Marine Draftsmen,* April.

PERSONAL

Edward B. Hill has been elected secretary and treasurer of the Fore River Shipbuilding Corporation, Quincy, Mass., succeeding the late Joseph A. Sedgwick.

Christoffer Hannevig, of New York, has been elected president of the Pusey & Jones Company, Wilmington, Del., vice Stirling H. Thomas, resigned.

James M. Bullowa, of New York, has been elected secretary of the Pusey & Jones Company, Wilmington, Del.

Henry Lysholm, of Philadelphia, has been elected vice-president of the Pusey & Jones Company, Wilmington, Del., vice Elbert H. Nesse, resigned.

H. E. Norbom, of Philadelphia, has been elected treasurer of the Pusey & Jones Company, Wilmington, Del.

C. Stewart Lee has been elected assistant to the president of the Pusey & Jones Company, Wilmington, Del.

Samuel Holmes, for over thirty-seven years prominently identified with the ship brokerage business in New York, has retired, and his business has been taken over by the Continental Trading Company of New York.

Dr. Joseph Struthers, formerly secretary of the American Institute of Mining Engineers, has become treasurer of the Federal Export Corporation and the Federal Shipping Company, Inc., New York.

Chauncey G. Whiton, for many years general agent of the New Bedford, Martha's Vineyard and Nantucket Steamboat Company, New Bedford, Mass., has recently acquired the managing interest in the New Bedford Towboat Company.

OBITUARY

Capt. Jared Gaines, well known as a former commander of Atlantic coastwise steamers, died recently at his home in Glastonbury, Conn., aged 69.

John S. Keen, for over thirty years master shipwright at the Cramp's shipyard in Philadelphia, died recently at his home in Philadelphia, aged 65.

Capt. Walter Baxter, late commodore of the Anchor Line fleet, and for over thirty years in the service of the Anchor Line, died recently at his home in Glasgow, aged 64.

Capt. Frederick W. H. Murrell, famous as the rescuer of the 733 passengers and crew of the steamer *Danmark* in 1889, died on June 9 in Baltimore, aged 54 years.

ENGINEERING SPECIALTIES

Q. M. S. Cold Metal Sawing Machine

In the Q M S cold metal sawing machine, illustrated, which has recently been placed on the market by the Vulcan Engineering Sales Company, Chicago, Ill., the saw and gear arbor, are of hammered open-hearth .60 carbon steel. The teeth are cut from the solid, and being staggered, back lash

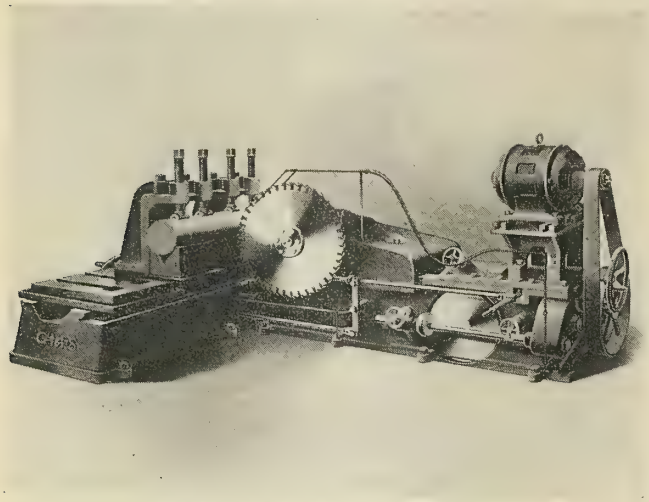


Fig. 1.—Q. M. S. Cold Metal Saw

and resultant chatter of the saw blade is reduced to a minimum. The main drive is through a worm and worm wheel, both encased and run in grease. Roller bearings take the end thrust of the worm. The carriage is of box section, with full-length bearing and hand adjustment, automatic stop and quick power return. Feed is accomplished by a combination

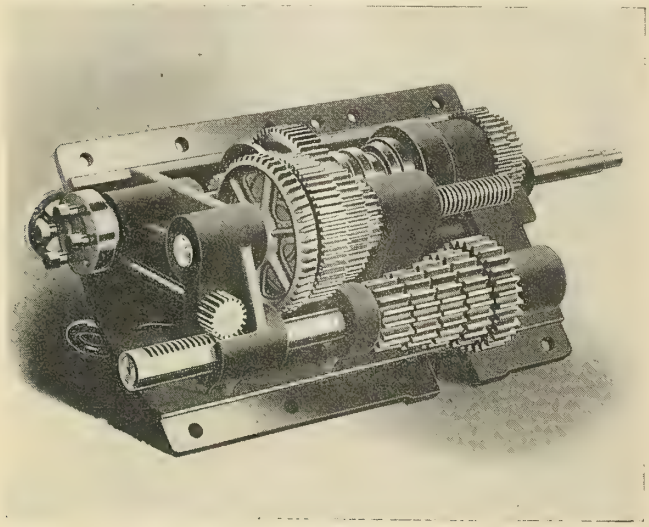


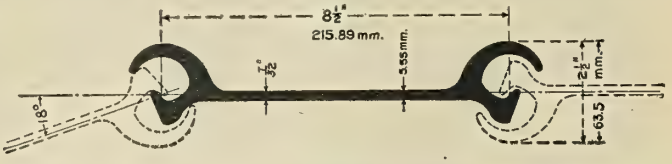
Fig. 2.—Gearing

of a friction disk and gears, providing a range of from 5/16 to 2½ inches per minute. The peripheral speed change is instantaneous, being arranged to run at either 30 and 50 or 40 and 60 feet per minute as desired. All of the gears run in oil, and the internal bearings are lubricated by oil pipes leading to the exterior of the machine.

A New Section of Lackawanna Straight Web Steel Sheet Piling

The new Lackawanna 8½-inch section, of which the illustration and table of properties are shown on this page, was designed to give a wider range of selection to users of Lackawanna steel sheet piling. This new section is of the standard Lackawanna straight-web type with interlock, consisting of similar hooks and guards on both edges, and is for use where a comparatively light section is required with high transverse strength and minimum weight, in medium trench and cofferdam work.

The interlock joint, formed between adjacent piles, is flexible through an arc of 18 degrees on each side of the center plane of the piling section. The hooks of adjacent sections engage to offer the greatest resistance to longitudinal displacement, while the guards overlap and engage the outer surface of the hooks on the adjacent sections, thus preventing



WEIGHT.		TRANSVERSE STRENGTH.		MODULUS OF SECTION.	LEAST RADIUS OF GYRATION	REMARKS.
LBS PER SQ. FT.	LBS PER LIN. FT.	PER SINGLE SECTION.	PER INCH OF WIDTH.	AVERAGE SECTION MODULUS PER HORIZONTAL FOOT OF WALL INTERLOCKED IN PLACE.		The efficiency of this pile per pound of metal (considering that the load will be in proportion to its width, also considering its high transverse strength and low weight) is comparatively very high, as can be demonstrated.
20.75	14.698	1.100 In.³	0.1294 In.³	1.553 In.³	0.509 In.	
PER SQ. METER IN KILOGS.	PER LIN. METER IN KILOGS.	PER SINGLE SECTION.	PER CENTIMETER OF WIDTH.	AVERAGE SECTION MODULE PER HORIZONTAL METER OF WALL INTERLOCKED IN PLACE.	LEAST RADIUS OF GYRATION.	
101.314	21.873	18.024 Cm.³	0.835 Cm.³	83.478 Cm.³	1.293 Cm.	

lateral displacement and co-operating to prevent longitudinal displacement. The joint can be disengaged only by withdrawing one pile. There are three lines of contact between the interlocked members of each joint, so that there is a positive, double, firm and close interlock, yet a minimum of friction in driving or withdrawing and ample opportunity for displaced material to work into the joint and assist in rendering it watertight, while at the same time the interlock holds the piling in proper alinement to form the wall.

In the development of this new section, special attention was given to secure for this joint high tensional and transverse strength, and at the same time to produce a pile which would have comparatively low weight per square foot; be simple, interlock perfectly and have the material so distributed as to give a high section modulus per lineal unit of wall.

Lackawanna steel sheet piling is made by the Lackawanna Steel Company, Lackawanna, N. Y.

Hele-Shaw Martineau Electric Hydraulic Steering Gear to be Manufactured in the United States by the American Engineering Company

The American Engineering Company, Philadelphia, Pa., has recently been appointed sole licensees in the United States for the design and manufacture of the Hele-Shaw Martineau electric hydraulic steering gear, manufactured in England by John Hastie & Company, Ltd., at Greenock.

This gear consists essentially of two or more hydraulic cylinders and plungers operating a crosshead attached in some convenient form to the tiller or rudder stock. The operation of these hydraulic plungers to the right or left operates the rudder to starboard or port, as predetermined by the piping and electrical connections. The power for operating the plungers is furnished by a continuous-acting variable stroke pump, driven by an electric motor. Power from the pump to the hydraulic plungers is transmitted through a high-grade oil, which fills the hydraulic cylinders and pipes. The electric motor operating the pump runs continually at a normal speed, but taking automatically only such current as is required to deliver the power which is needed by the pump in its operation.

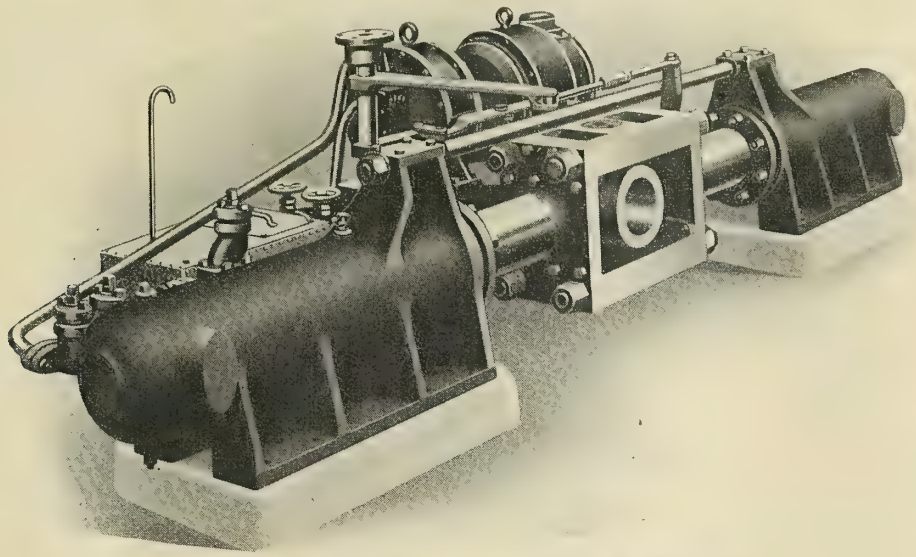
The pump has a sliding head inside of its cylinder, and this is operated so that the direction of the pump is reversed, and the amount of liquid pumped is varied according to the position of this head. With the sliding head in an extreme position (right or left), the maximum flow of liquid is caused, but at a minimum pressure, whereas with the sliding head slightly removed from the central position the amount of liquid delivered is very small, but the pressure is very great, running to the maximum required.

Under usual conditions, the tilting head is operated by an hydraulic telemotor of the standard steering engine type controlled from the pilot house or bridge. Other means of operating the head with equal efficiency may be provided, however, such as by a pilot motor as described in our April issue, or by means of a wire rope transmission or by shafting.

The special advantages claimed for this type of electric steering gear are: (1) absolute reliability; (2) economy in

running costs; (3) extreme sensitiveness and responsiveness to the action of the helmsman; (4) absolute silence when operating; (5) simplicity of construction; (6) economy of space, and (7) durability—minimum of repairs.

As an example of economy, the steamship *Orama,* a vessel of 13,000 tons displacement, which is equipped with this steering gear, cruised 120,000 miles at a speed of approximately 18 knots without any repairs to the gear whatever, and with an average consumption of electrical energy for the steering gear of about 2.4 kilowatts per hour.



Hele-Shaw Martineau Electric Hydraulic Steering Gear

The American licensees of this apparatus are in an especially advantageous position for taking up the manufacture of this type of steering gear, owing to the more than 50 years of experience which they have had in the development and manufacture of steering gears and other auxiliary ship machinery.

Among the many steamship lines in the United States using this device, in addition to the United States navy, are the American-Hawaian, Old Dominion, New York & Porto Rican, Southern Pacific, Mallory, Isthmian, Ward, Pacific, and all of the Standard Oil lines.

Fire Helmet

The United States Government is using on its warships a new fire helmet manufactured by the Maxwell-Hood Manufacturing & Selling Company, New York, as a protection against not only smoke but ammonia and gas fumes. Where smoke or poisonous gases are encountered it is claimed that any inexperienced operator can adjust the helmet at an instant's notice, and thereby assist in saving property, and in many cases loss of life. An operator using this helmet, it is claimed, can remain about ten minutes in any space filled with smoke or deadly fumes with perfect safety, when the helmet can be refilled in a second and is ready for further use. Moreover, with the helmet on, the operator can hear and be heard; and as the helmet is so light and occupies so small space it can be carried in the operator's pocket without difficulty. The helmet is treated by a process which makes it non-inflammable, and with ordinary care it is claimed that it will last from six to eight years in constant use.



Views of the Helmet in Use

Year's Record at Large Japanese Shipyard.—The largest shipbuilding plant in Japan is in Nagasaki. Less than 30,000 workmen are engaged in shipbuilding in the country, and more than 10,000 are employed here. The plant is called the Mitsu Bishi Dockyard & Engine Works, and does an enormous amount of repair work besides building ships. It has docks ranging in length from 350 to 714 feet and a patent slip capable of lifting a vessel up to 1,000 tons gross. It also maintains a salvage steamer of 716 tons with a speed of 12 knots.

The plant was considerably extended last year and still further extensions are planned. The principal ones were: Fitter shop, cast iron surface table of 1,470 square feet, and one 20-ton overhead traveling crane with motor; machine shop, horizontal boring, drilling, facing and studding machine with motor, 20-ton overhead traveling crane with motor, and 12 lathes; turbine shop, pinion hobbing machine; boiler shop, electric welding plant and hydraulic boiler plate bender; pattern shop, 10-ton overhead traveling crane with motor; crane department, 34-ton floating crane; shipbuilding berth, No. 5 shipbuilding berth, 430 feet long and 28 feet broad, and tugboat *Manazuru-Maru,* 181 gross tons.

During last year and this there has been a serious shortage of foreign material. Japanese shipbuilders are greatly handicapped by the necessity of purchasing many requisites from foreign countries. This is especially true of engines, boilers and general fittings for the equipment of steamers. It is true also, but to a smaller extent, of iron and steel construction materials. Such materials are largely made in Japan, but the quantity is altogether inadequate. At present there is an active demand for such products, and particularly for steel sections.

Losses to Merchant Shipping.—According to data compiled by the *Journal of Commerce,* the total losses to merchant shipping arising from the war up to June 1 have been about 1,272 vessels of more than 2,585,362 gross tons. Approximately 57 merchant vessels of all types, having an aggregate gross tonnage of about 116,724, were destroyed during the month of May.

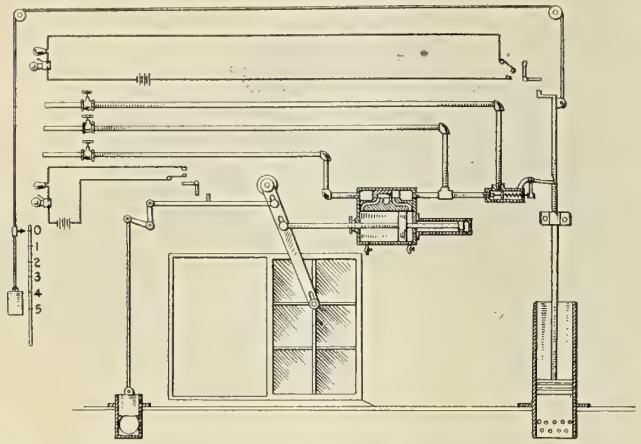
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

MECHANISM FOR OPERATING WATERTIGHT BULKHEAD DOORS. JAMES N. PRIEST, KEARSBURG, N. J.

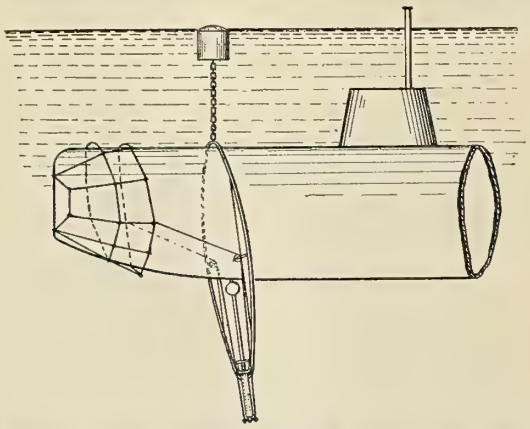
Claim 8.—In combination with a door movably mounted, fluid pressure means for moving the door, a valve for controlling the supply of fluid pressure to the fluid pressure means, a cylinder provided in the



vicinity of its lower end with openings, a float movably mounted in the cylinder, and means operatively connected with the float and the valve for moving the valve in consequence of the movement of the float. Eight claims.

1,173,463. SUBMARINE DESTROYER. JESSE W. RENO, OF NEW YORK, N. Y.

Claim 1.—In a submarine destroyer the combination with a ring and means for supporting said ring in the water, of an explosive bomb secured



to said ring and means connected with said bomb and said ring adapted to explode said bomb when a body enters said ring, said means being inoperative by contact with bodies external to said ring. Six claims.

1,175,483. FREIGHTER. CHARLES R. STEINER, OF NEW YORK, N. Y.

Claim 1.—For combined inland and oversea waterborne freight traffic non-sectional, shallow water freight barges of such standard size and construction as to suit prearranged chambers of sea-going ferryboats with



sea-gates, said barges provided with special reinforcements as will be necessary for them to support their full load in the dry space, each barge on three selected supporting surfaces, which are provided on cushions, fixed on the chamber bottom of the ferryboat; each barge provided with sufficiently strong, perfectly uniting, but promptly releasable coupling devices with contact surfaces, corresponding in distance and size accurately to reciprocal ones on the ferryboat. Two claims.

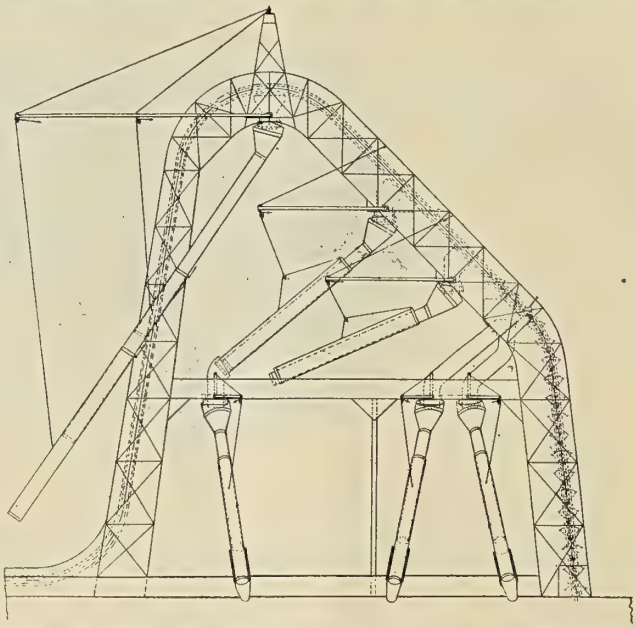
1,173,726. ESCAPE APPARATUS FOR SUBMARINE BOATS. DAVID C. MARSHALL, OF NEWARK N. J.

Claim 1.—An escape apparatus for submarine boats comprising a well connected with the deck of submarine boat, a hatch connected with the bottom of said well and communicating with the interior of said boat, a hatch-plate for normally closing said hatch, a collapsible tubular body providing an escape passage secured by its lower end to said hatch and in communication therewith, said tubular body when collapsed being stowed in said well, a buoy normally confined in said well, flexible connecting means securing said buoy with the free end of said tubular body, a line passing longitudinally through said tubular body, a cover member for normally closing said well, and means for removing said cover member from closed relation to said well operatable from within the interior of said boat. Five claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn place, W. C., London.

24,008/14. COAL BUNKERING VESSELS. W. G. READ, OF WHISTON, PRESCOT, LANCASHIRE.

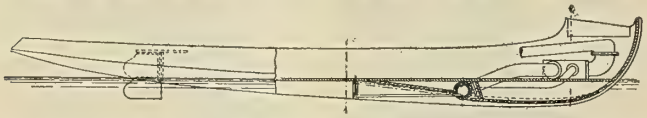
This invention relates to coal bunkering vessels of the kind in which the coal is raised by a bucket conveyor from the hold of the vessel up a tower structure, where the coal is dumped, and descends chutes, which deliver the coal into side ports or hatchways of the vessel which is being coaled. The object is the provision of a coal bunkering vessel capable of delivering coal either by high chutes into hatchways or by



low chutes into side ports, without necessitating for side port work the coal being raised to and dumped from a height much exceeding the height of the side port chutes. Incidentally the invention also enables hatchway-delivering chutes to be employed at different heights to suit the prevailing circumstances, or intermediate chutes to suit either low hatchways or high side ports to be used.

2,298/15. IMPROVED CONSTRUCTION OF VESSELS AND APPARATUS FOR EFFECTING PROPULSION THEREOF. F. W. SCHROEDER, OF 388 KENNINGTON ROAD, LONDON.

This invention relates to an improved construction of vessels and apparatus for effecting propulsion thereof, of that kind in which the propulsion is effected by directing air or other gases under pressure through a series of longitudinal tubes provided under the forepart of the bottom of the vessel, which tubes are provided with orifices or nozzles directed oppositely to the direction of propulsion. The air tubes extend aft from suitable housings arranged transversely to and dis-



posed on either side of the keel. Each housing forms a tube at its inner end with a removable cover at the outer end and is supplied with compressed air by pipes from one or more reservoirs in which the air is maintained at a suitable pressure by means of air pumps driven by petrol motors or other prime movers. An inner tube is fitted into each housing and the arrangements are such that the series of parallel air tubes extending aft and fitted into the inner tube are capable of a certain amount of vertical movement by rotating the inner tube in the housing, by which their inclination to the water surface can be controlled in order to adjust, as may be required, the propelling power of the expelled air on the vessel and consequently the speed of the latter. The arrangement also enables the tubes to be raised in order to prevent any damage which might be occasioned by obstacles in the water.

8,102/15. IMPROVED ATTACHMENT AND RELEASING GEAR FOR BOAT TACKLE. J. BOWDITCH, OF MAITLAND ROAD, ISLINGTON, IN THE STATE OF NEW SOUTH WALES, COMMONWEALTH OF AUSTRALIA.

This invention relates to releasing gear for boat tackle of the kind comprising a pivotally mounted hook adapted to engage a chain-link or the like of the raising and lowering tackle, the hook being held in angagement with said link by a pawl, means being provided for effecting the disengagement of said pawl to permit the opening of the hook. It is usual to place such a device at each end of the boat and to connect the two devices by levers whereby both devices are simultaneously operated. The invention has for its object to provide an improved appliance for the purpose stated affording great facility for instantaneously releasing the boat at the critical moment.

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Shipbuilding Outlook

THE latest reports from the Department of Commerce show that the United States is not only building more merchant shipping at the present time than any other country in the world, but that the output of American shipyards for the year 1916 will probably exceed that of all the rest of the world. On July 1 there were no less than 385 steel merchant vessels of 1,225,784 gross tons building or under contract to be built in private American shipyards, and in addition there is now before Congress a naval appropriation bill providing for the largest building programme in the history of the country. Barring delays, the shipbuilders expect to launch 327 steel ships of 927,893 gross tons during the current fiscal year and 58 vessels of 297,891 gross tons during the following fiscal year. With the continuation of the European war there is little doubt but that the latter figures will be greatly exceeded, provided labor troubles do not diminish the output and steel makers are able to meet the demands of the shipbuilders.

With such a favorable outlook there is good reason for the continued expansion of existing shipbuilding facilities in the United States and the addition of new yards to meet future demands. The naval appropriation bill in the form in which it passed the Senate on July 21 provides for the construction of no less than 157 vessels of approximately 855,000 tons displacement, 66 of which, of about 382,000 tons displacement, are to be begun as soon as practicable, and the remainder before July 1, 1919. To carry out such a liberal programme of naval construction the nation must look as heretofore to the initiative and enterprise of private shipbuilders. The facilities of naval establishments for shipbuilding are entirely inadequate to cope with such a programme, and the delays involved in providing the necessary facilities in the navy yards to undertake more than a small part of such work effectively would defeat the purpose of the programme.

Merchant Submarines

WHILE the submarine boat was developed primarily as a war vessel, its possibilities for commercial purposes have frequently been pointed out in these columns. Its field of usefulness in commercial work, however, has been conceded to lie in the direction of hydrographic work, scientific investigations below the surface of the sea, recovery of lost cargoes, dredging, wrecking and other underwater enterprises, rather than in the direction of commercial transportation. The exigencies of war and blockade at sea, however, have furnished the opportunity for the entrance of the submarine into the field of maritime commerce, and during the past month the first merchant submarine has made its appearance at a United States port after a voyage of about 3,800 miles from Bremen, Germany.

The enterprise, skill and courage shown in successfully carrying out this difficult undertaking are fully recognized, and presumably the results from a commercial standpoint will repay the risk involved, as the *Deutschland* is but the first of a fleet of similar vessels which are being constructed for this service. The *Deutschland* is about 315 feet long, 30 feet beam, and on a draft of 17 feet has a displacement of about 2,000 tons. Her cargo carrying capacity is about 700 tons and her speed when driven on the surface by two four-cylinder Diesel engines of 600 horsepower each is from 12 to 13 knots. The submerged speed is slightly less than half the surface speed.

While the construction and performance of the vessel, so far as disclosed, reveal no unusual features from an engineering standpoint, the nature of the undertaking is sufficiently unique to center public attention upon her exploits as a pioneer submarine merchantman. It will be remembered that even more hazardous voyages of greater length have been successfully accomplished since the beginning of the war by naval submarines.

Geared Turbine Driven Tank Ships

SINCE the steam turbine was first adopted for the propulsion of ships, no other development has given greater promise of universal application than the introduction of speed reduction gearing between the turbine and the propeller shaft. The gradual perfection of different forms of gearing for this purpose has led to the possibility of the general application of economical high speed turbines to single screw slow speed cargo boats with advantageous savings in machinery weights and fuel consumption.

Elsewhere in this issue will be found descriptions of two tank steamers of somewhat different types, but of nearly the same size, both of which are fitted with turbine drive through mechanical reduction gears. In both cases the vessels are duplicates of other ships either built or under construction, equipped with other types of propelling machinery, so that after the vessels are in service valuable comparisons of their relative performances can be made.

One fleet of ships is designed for carrying either molasses or petroleum in bulk and the other for the carriage of oil. In the turbine driven molasses tank steamer the propelling machinery consists of a five-stage Curtis turbine, driving a single right-handed propeller through a double reduction gear. The turbine is designed to run at about 3,300 revolutions per minute and the propeller at 75 revolutions per minute, making a speed reduction of 30.6 to 1. The gearing is arranged in two elements, the high speed gear consisting of a single high speed pinion

driving two double helical wheels, and the low speed gear consisting of two pinions driving a single double helical wheel.

In the turbine driven oil tanker described in the second article the propelling machinery is of the Westinghouse type, consisting of a cross compound, double reduction geared turbine unit, running at 3,600 revolutions per minute and driving a single propeller at 70 revolutions per minute. The shaft horsepower developed by the turbines is 2,500 and the total machinery weighs only 68.7 tons, making the weight of the machinery 61.5 pounds per shaft horsepower, or 56.5 pounds per indicated horsepower, as compared with about 110 pounds per indicated horsepower for reciprocating machinery of the same power.

The Status of Cargo Handling in American Marine Terminals

BY JAMES A. JACKSON AND ROBERT H. ROGERS *

THIS article is a digest of two papers by the above writers, read before the International Engineering Congress in San Francisco in September, 1915. The natures of the papers are such that the salient points are readily combined in this article to indicate the status and trend of the methods and apparatus used in the handling of bulk and package cargoes in our marine terminals.

Bulk freight consists of free-flowing material, such as coal, ore, grain, certain fertilizers, etc., which can be transported and handled in bulk. The classification of bulk freight can be carried only two steps, viz., kind of material and weight; and this simplicity has been a large factor in the development of the rapid means now used for handling such freight.

The history of the handling of bulk or free-flowing freight makes interesting reading, and there is probably no better place to follow it out than on our own Great Lakes, where the development of rapid, economical handling has been carried to a very high degree. With this development of freight handling our readers are thoroughly familiar.

Miscellaneous or package freight, however, presents the most serious problem, as it forms the greater part of all freight, both in weight and bulk. The varying size, shape, strength and weight of packages make its classification an endless task; a single cargo often containing 50,000 to 100,000 packages, divided into hundreds of different sizes, shapes and weights, and consigned to several hundred different parties. The transportation companies have an elaborate system of classifying this package freight to determine the freight charges, but such a classification would be of little value so far as handling is concerned. A classification based on size, weight and shape would be the logical way of attacking the problem.

Miscellaneous or Package Freight

The greatest advance toward dispatch and economy is attained in terminals by the use of mechanical devices for handling freight in and out of ships, to and from storage piles and warehouses, and into and out of cars. Many of the larger and more progressive ports are investigating and testing various electrical machines, and there is, at present, quite a commendable quantity of such machinery in the package freight work; but the surface has hardly been disturbed as yet, either in the design of such devices or in their general adoption. A brief review of progress, to date, along these lines is too important to be omitted.

* Power and Mining Engineering Department, General Electric Company.

Winches

Electric winches, single, double, and with one or two motors, are in quite general use to supplant or supplement the ship's cargo winches. Head frames are provided on pier buildings to accommodate one whip, while the other is trained through the block or the ship's boom. Such apparatus provides greater speed, with greater safety, than is the case with steam, due to the uniform speeds, ample power braking and quickness of control that electricity provides. The most recent innovation in this country in this line is the use of a double portable master-controller carried by the winch operator, which gives him perfect control of both drums from any convenient position on the ship, or elsewhere. The advantage of always having the draft in sight adds greatly to the dispatch, and this end can be attained in no other way.

Conveyors

Sectionalized portable conveyors of ingenious design and great utility are rapidly becoming common on the piers, where they are used to discharge from the decks of ships, lighters or barges to the pier or storage pile, without rehandling. A single whip, or two working in multiple from the same hatch, supply the conveyor, which makes the horizontal transfer at great speed. A remarkable feature of this type of machine is its reservoir capacity, or flywheel effect, by virtue of the receiving area provided through its constantly presenting new empty surfaces to the loading device. Power consumption is very low, and the machines are not expensive to install or limited in their application.

Cranes

While much relied upon abroad, cranes are but little used along our coasts in the package cargo handling. Some of the most notable are: The banana conveyor cranes at New Orleans (ten in number), each with a capacity of forty-two bunches per minute; the battery of cargo cranes at Balboa, Panama Canal; and the variety of types seen about New York harbor, which, however, are largely used for lighters and barges.

So much depends upon the proper storage of cargo in ships that much improvement in dispatch in that direction cannot be looked for with package freight.

One of the most striking advances in dispatch is found in the use of a portable electric crane for loading and unloading gondola and flat cars.

Another system which speeds up internal movements of freight is the trailer and tractor plan, whereby simple platform four-wheel trucks are towed in groups by an electric tractor, which carries no load itself. Trailers are provided far in excess of the number towed at one time, so that the tractor never waits for loading or unloading, but picks up the trailers that are ready each time.

The pressure of factory production is as nothing compared with the pressure that traffic puts on the terminals. Each day's burden must be disposed of to make place for to-morrow's load. Like a man in a leaky boat, who must keep bailing or be swamped, the terminals are ever faced by the grave emergency of congestion, where dispatch is no more, and the trouble spreads to unbelievable distances along the arteries of commerce. The ample provision of varied and well-adapted machinery is the simplest method of attaining dispatch and retaining it.

Industrial Trucks

These little machines are readily operated by longshoremen, and when the surrounding conditions are right, they cut the costs of moving freight to a marked extent. They work to best advantage on packages that can be readily handled by one or two men, because each piece has to be

lifted on or off by hand, or by some other means. The distances must be rather great to make a good showing over hand trucks, and the approaches to loading and unloading points must be good.

Car Pullers

These machines may be vertical or horizontal; the vertical type can be set into a wharf, so that the drum only is visible. These pullers are very handy in minor car movements that would not warrant the calling of a switch engine. While the savings effected by these devices are indirect, they are nevertheless important. By moving cars from twenty to fifty feet the cost of unloading or loading them can sometimes be cut in two; whereas, without this convenience, hand bars would have to be resorted to or work done in an inconvenient manner.

Portable Cranes

The type using a storage battery for its source of power has a wide range of utility, with its most marked economies in the loading and unloading of gondola and flat cars. The machine, being a combined crane and electric truck, makes one handling of iron pipes, structural steel, timbers, logs, etc., between car and storage pile and gives the added advantage of economical tiering. Its greatest usefulness lies in short lifts of heavy weights, with moderate distance transfers. Another type is actuated by means of a motor having a cable leading to a receptacle or service station forming a part of the power distribution system. This machine is not self-propelling and is used principally to give unrigged barges, floats or lighters a rapid and economical cargo-handling equipment equal to or better than that of ships. These devices make the best showing on quantities of freight in units up to 1,000 pounds weight and requiring a considerable vertical movement. They discharge onto industrial trucks, trailers or hand trucks, or receive from them when loading boats.

Air, steam and water have been used to actuate cargo machinery; but just as electricity has superseded all other forms of power in all large industries, so will it be universally adopted for cargo handling machinery. Ship's boilers or donkey boilers should not be depended on for cargo handling machinery, as they have not proved reliable. Central station electric power is available in all port cities and is sufficiently reliable to meet the requirements demanded of it by dock machinery.

Direct current seems ideal for this service, as control and wiring problems are much simpler and more satisfactory than with alternating current. However, alternating current can be used satisfactorily, if necessary. With either direct or alternating current the most desirable voltage is from 220 to 250, from the standpoint of safety and insulation.

Terminal Accessories

Terminal accessories are of great importance and interest, and while not directly involved, they influence greatly the safety, despatch and economy of great commercial centers.

At large progressive seaports, particularly at those whose facilities are in part or wholly publicly owned, many provisions for the safety of rolling and floating property are to be found, and are becoming considered in a greater degree. Among these tendencies may be noted: The deepening, widening and straightening of approach channels, with improved buoying and lighting by Federal authorities, is doing much to make safe and easy the arrival and departure of shipping. Compulsory piloting, while deemed a hardship by some navigators, tends toward reducing losses by collision or grounding, especially in ports where tidal and current conditions are severe and changeable. The gradual increase in the size and power of harbor tugs and the wonderful skill of tugmen are factors agreeable to all who go down to the sea in ships.

In ports such as New York, where there is much car float traffic, recent improvements in floats and float bridges are notable additions to harbor and property safety features. The newer, all steel, watertight compartment floats, carrying twenty and more cars, are practically non-sinkable, and much more care and judgment is being used in the design and equipment of float bridges, thereby minimizing the damage to and loss of freight cars in this peculiar branch of traffic.

Design of Cargo Boats

In the design of cargo ships, many improvements are manifest, looking to speedier discharging and receiving. The new cargo boats have large steam winches in greater numbers than formerly prevailed; and well they may, for the standby charge on a moderate sized ship runs from $300 to $500 (62/10/0 to 104/3/4) per day, and money cannot be better invested than in facilities tending to shorten the stay in port. Modern coastwise ships are provided with more and larger side ports. It is a new and good practice to provide an elevated position for the cargo winches, leaving a clear deck for deck loads and placing the winch man in a more commanding position. Hatch covers have gone in for their share of attention, and the old standard strongback construction, with hand boards, is giving way to hinged steel trap doors of clever design that are quickly handled by the cargo winches and provided a certain closure when at sea.

The holds of the newer ships are free, or nearly so, from the stanchions that so profusely stud the working spaces of the older ships. The former tendency to specialize ships for certain cargoes has not been found expedient, as commerce does not usually provide similar cargoes both ways, consequently the normal cargo carrier is almost a universal ship. Donkey boilers are now of more liberal capacity, as in the older ships much delay is caused by lack of steam for all the winches without firing up the main boilers.

Summary

In review of the whole field the costs of handling freight through terminals is enormous as compared with the cost of hauling the same freight from place to place. The reason for this high cost is the universal use of manual labor, which has been retained largely because it is plentiful in the coast cities. The farmer has not adopted his wonderful machinery, to the almost entire exclusion of manual labor, from any love for machinery, but from dire necessity. His load factor is low, for his machinery is of special nature for seasonal work, a couple of weeks per year being an average condition. With the terminals, the load factor could be nearly 100 percent, but not being forced into its use by the absence of good labor, the terminals have been satisfied to work along the old lines. The use of machinery well adapted for the work has in many cases cut the labor costs to one-fourth the figure that formerly prevailed.

Broadly speaking, the future trend is toward more machinery for cargo handling. Three important steps must be considered in order to bring about the adoption of machinery: First, the educating of steamboat companies, stevedores and labor unions to see its advantage; second, the design of vessels and piers to be especially adaptable to the use of machinery; third, a systematic scientific study of freight and freight movements.

MOLASSES TANK STEAMER BUILT BY THE FORE RIVER SHIPBUILDING CORPORATION



Fig. 1.—S. S. *Sucrosa*



Fig. 2.—S. S. *Cubadist*

Geared Turbine Tank Steamer

Description of Sister Ships Built at the Fore River Yard for Carrying Molasses or Petroleum

AN interesting vessel recently completed by the Fore River Shipbuilding Corporation at Quincy, Mass., for the Cuba Distilling Company of New York, is the single screw, turbine reduction, gear driven steamer *Sucrosa*. This vessel, together with her sister ships, the *Cubadist,* recently delivered, and the *Mielero,* now under construction, were designed by the shipbuilders' naval architect to the owners' special requirements for the carriage of either molasses or petroleum in bulk between Cuba and ports of the United States.

As will be seen from the accompanying plans and photographs, the *Sucrosa* is a vessel of very pleasing appearance and of symmetrical, well-balanced design, and worthily upholds the enviable reputation the Fore River Shipbuilding Corporation has attained for designing and building high grade vessels.

The *Sucrosa* is a two-deck vessel with a top gallant forecastle, short bridge and long poop, with three masts and one smokestack and machinery located aft, and is of the following dimensions:

Length overall	406 feet 4 inches
Length between perpendiculars	389 feet
Breadth, molded	54 feet 6 inches
Depth, molded to upper deck	32 feet 6 inches
Designed draft	25 feet
Deadweight carrying capacity	8,120 tons
Gross tonnage	5,788
Net tonnage	3,608
Designed speed	11 knots

The vessel is built on the transverse system under the special survey of Lloyds Register of Shipping to Class 100-A-1, for carrying petroleum in bulk. Unlike the usual design of bulk liquid carrying vessels, the *Sucrosa* has a double bottom extending all fore and aft, being 4 feet 3 inches deep forward of the engine room and 6 feet deep under the machinery. The introduction of the double bottom has the effect of raising the center of gravity of the heavy molasses cargo which varies between 11 pounds and 14 pounds per gallon, and, furthermore, permits the provision of large wells in each main tank at the pump suction bell mouth, thus insuring an almost complete clearance for the cargo. When carrying molasses the cargo is carried in the main tanks above the inner bottom, while in carrying oil both the main tanks and the double bottom tanks are utilized, the latter having a pumping system independent of the former.

The *Sucrosa* is subdivided by 11 oiltight bulkheads, 2 watertight bulkheads and 2 non-watertight bulkheads, into 9 cargo tanks, a pump room, cofferdam, coal bunker, machinery space and fore and aft peaks.

The total capacity of the main cargo tanks is 2,342,500 gallons, and of the double bottom tanks 382,000 gallons, not including the tanks used for water ballast or reserve feed water. The coal bunkers have a total capacity of 930 tons, including a 15-ton bin for galley coal. The 'tween deck spaces outboard of the expansion trunk have a capacity of 50,200 cubic feet and are fitted up for the carriage of general freight with the frames battened.

Accommodations

Owing to the extreme heat often experienced in Cuban waters, special attention has been given to the arrangement of quarters and the ventilation of same, and, as will be seen from the accompanying plans, the quarters throughout the vessel are unusually large and airy and arranged with a view to the comfort and welfare of officers and crew. All cabins and main passageways to same are provided with individual ventilators, fitted with cowl top where used for supply and mushroom top where used as exhaust, in addition to which a large number of 12-inch electric bracket fans are furnished. The air to pump room is supplied through two 18-inch cowl vents, one of which may be, when desired, connected to a Sturtevant steam-driven exhaust fan of large capacity, which is used for drawing and expelling overboard the heavy fumes liable to generate and lay around the bottom of pump room when discharging cargo.

Accommodations are provided in the bridge space for the officers, with a saloon, guest room, pantry, baths and toilet. The captain's quarters are located in bridge deck house.

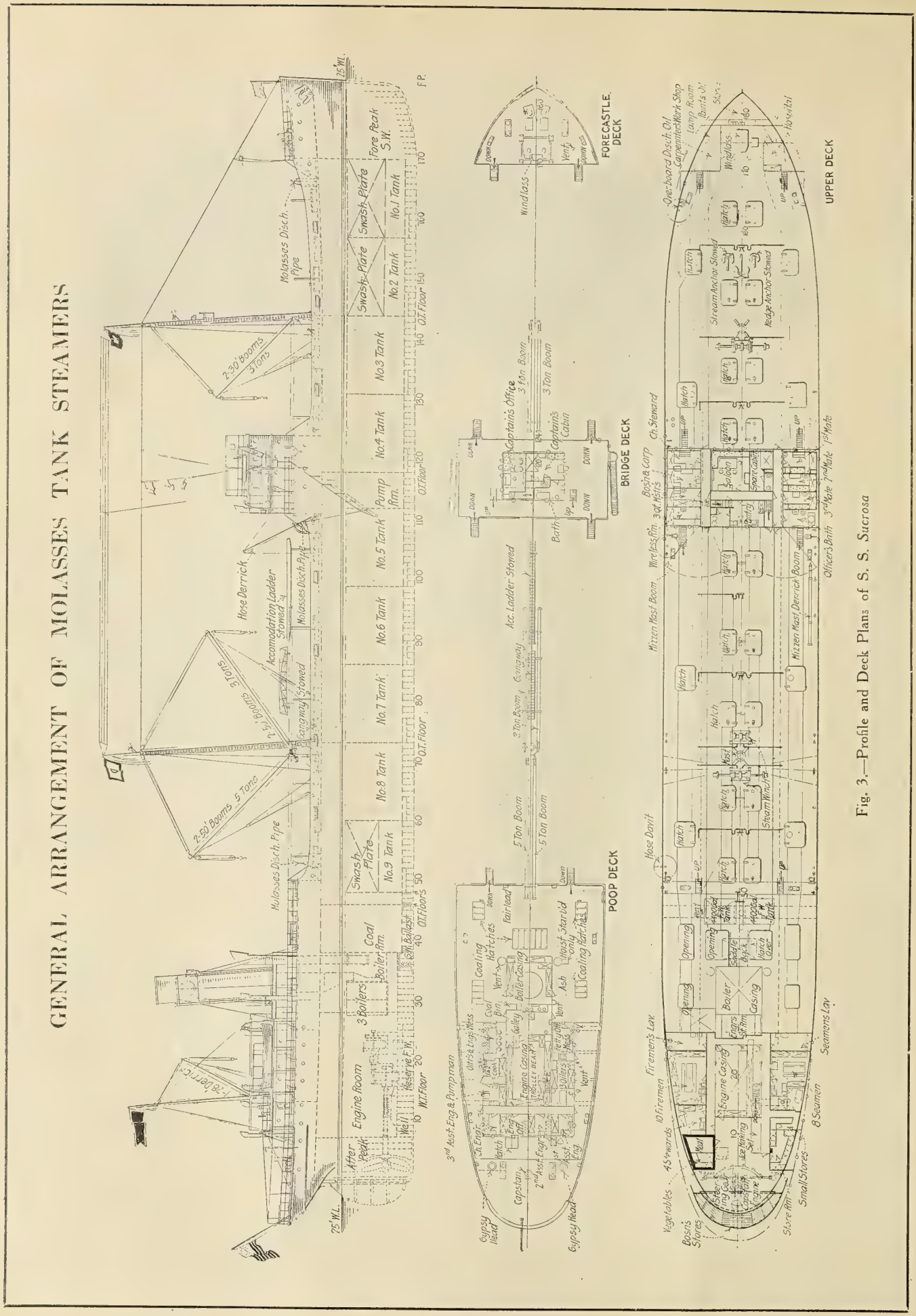
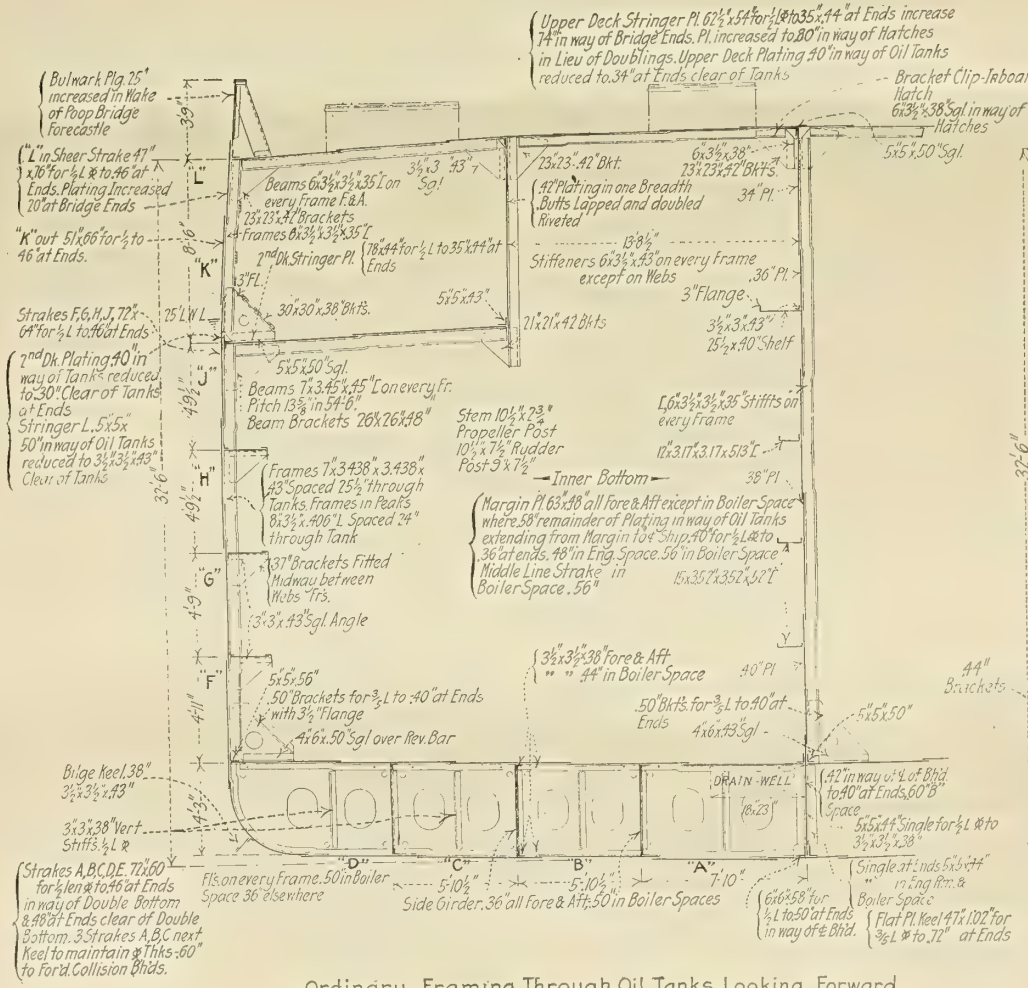


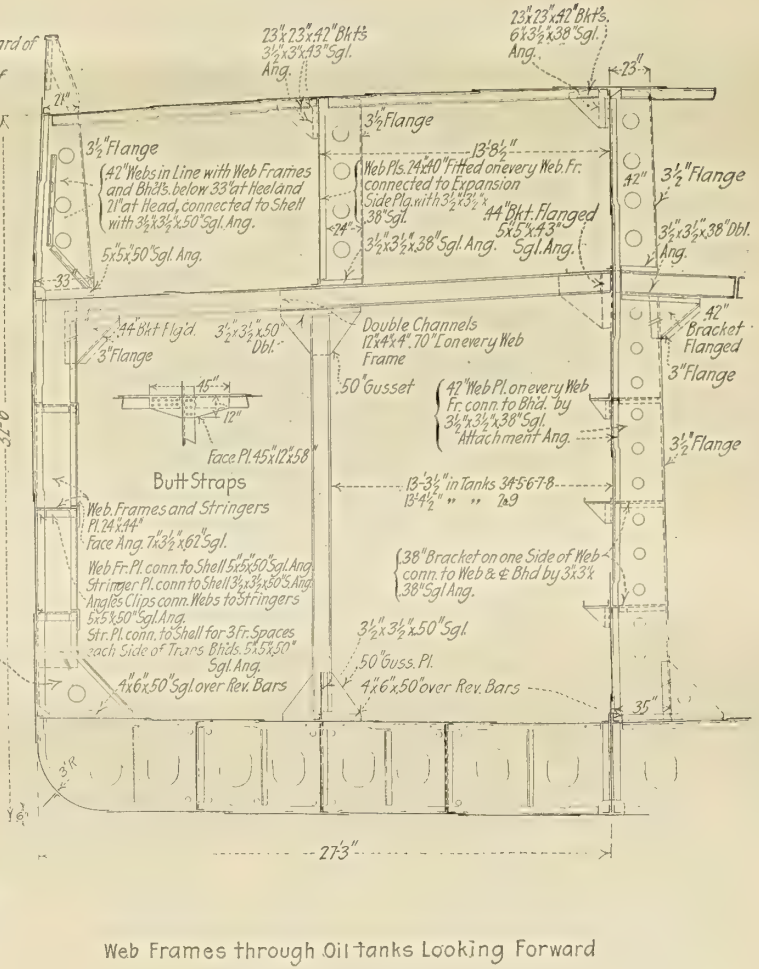
Fig. 3.—Profile and Deck Plans of S. S. Sucrosa

CROSS SECTIONS OF TANK STEAMERS, SHOWING SCANTLINGS



Ordinary Framing Through Oil Tanks Looking Forward

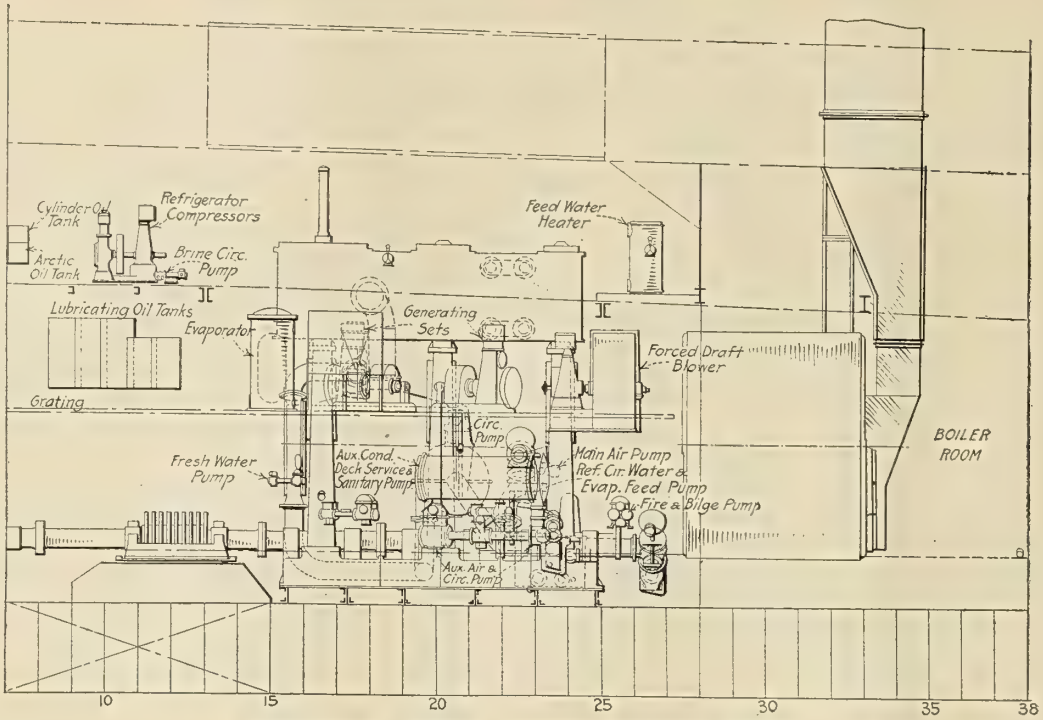
Fig. 4



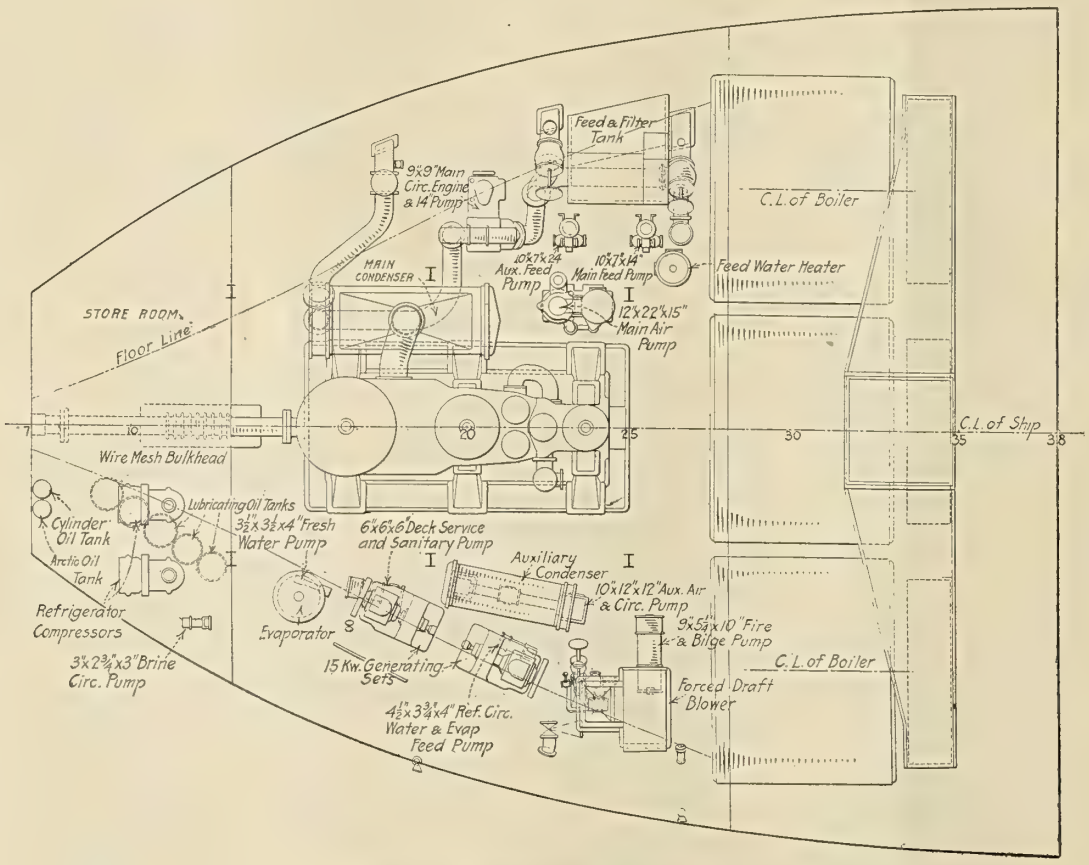
Web Frames through Oil tanks Looking Forward

Fig. 5

MACHINERY ARRANGEMENT, S. S. CUBADIST



Longitudinal Section Through Machinery Space



Plan of Machinery Space

(Figs. 6 and 7)

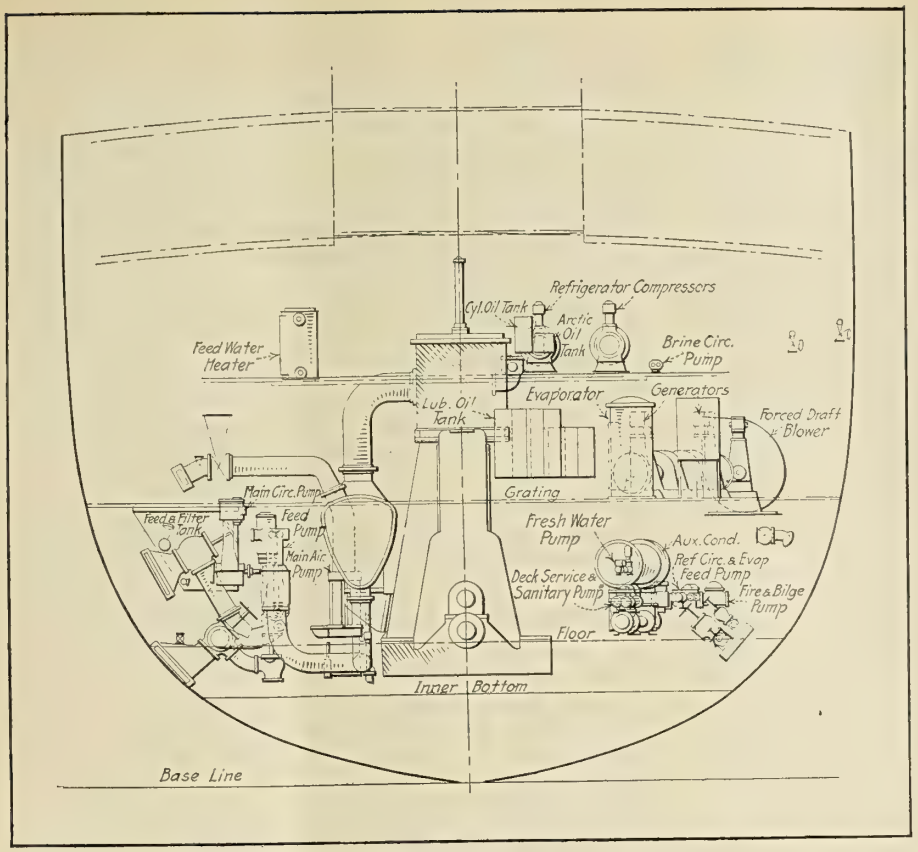


Fig. 8.—Section Through Engine Room of S. S. *Cubadist*

The long poop encloses quarters for the firemen and seamen and in the Liverpool house on the poop deck are arranged the engineers' quarters, with officers' and engineers' mess room, bath and toilet.

The poop deck in way of the deck house is planked with 3-inch by 5-inch Oregon pine having a 10-inch margin plank worked in way of the deck house and waterway. The bridge deck, bridges and housetops are laid with 1¾-inch by 3½-inch T & G yellow pine, covered with canvas. The flats of coal bunkers are laid with two thicknesses of 1½-inch North Carolina pine. The floors in officers' quarters are covered with linoleum. The galley floor is laid with waterproof cement and the bathrooms with ceramic tile. The pilot house and chart room are built of teak.

The joiner work and furniture in the quarters is finished generally in North Carolina pine, except in the saloon and guest room, which is finished in oak. Transoms and seats are upholstered in maroon pantasote.

The sanitary arrangements are very complete, all fixtures being supplied with running water. The salt water is kept under pressure by a salt water sanitary pump, while the fresh water flows by gravity from a daily service tank supplied by the fresh water sanitary pump. The officers' bath and lavatories are supplied with hot as well as cold water.

Cargo Handling Appliances

The vessel is rigged with three pole masts, the fore and main masts being of steel and the mizzen mast of wood. The cargo booms are of wood and consist of two 38-foot booms on the foremast, each of 3-ton capacity, four 50-foot booms on the foremast, two of 3-ton and two of 5-ton capacity. A small boom is provided on the mizzen mast for handling engine room weights and stores.

The method of handling liquid cargo has been designed to meet the special requirements of this trade, and has proven eminently satisfactory under service conditions. The main cargo pump is a horizontal 18-inch by 12-inch by 18-inch duplex Blake pump, located on the port side of the pump room amidships. From this pump a 14-inch suction line is run the whole length of cargo tanks with a 12-inch branch to each tank, port and starboard, with each branch fitted with a gate valve and terminating in a bell mouth, the bottom of which stands within ¾ inch of the bottom of the wells in the double bottom plating previously referred to. The discharge is led through a 10-inch pipe on each side of the vessel, run through the 'tween deck wing compartments, and provided with branches to the main tanks and three overboard discharges above the upper deck, located one just aft of the forecastle enclosure, one just aft of the bridge and one just forward of the poop deck enclosures. This arrangement of piping permits the pump to draw from any one of the eighteen tanks and discharge into any other tank or overboard on either side of ship, forward, aft or midships. There is also provided in the centerline bulkhead and transverse bulkhead of each tank a 12-inch sluice valve, so that cargo may be run by gravity from one tank to the other if so desired. All valves in the cargo holds are operated from above the upper deck.

Pump Room Auxiliaries

In addition to the main cargo pump there is a 16-inch by 10-inch by 18-inch horizontal duplex Blake ballast pump located on the starboard side of the pump room. This pump is arranged either to handle molasses from the main tanks as an auxiliary to the main pump, or to handle the oil cargo in the double bottom tanks independent of the main pump. An independent suction line, both port and starboard of the centerline bulkhead, is led to each double bottom tank and connected to manifolds in the pump room, which are, in turn, connected up to the ballast pump and provided with an emergency connection to the cargo pump.

Geared Turbine

The propelling machinery of the *Sucrosa* consists of a five-stage Curtis turbine driving a single right-handed propeller through a double reduction gear. The turbine is designed to operate at about 3,300 revolutions per minute with boiler steam at a pressure of 190 pounds per square inch. It is of very strong construction and the parts are made of the highest class metal to enable it to operate satisfactorily at these high speeds. The astern turbine is fitted in the same case with the ahead turbine and is designed to give approximately 50 percent of the go-ahead power. The shafting and wheels are made of chrome nickel steel and the blading is of monel metal. The bearings are of the self-adjusting type and the running parts are carefully balanced when running, so that the turbine will operate without vibration. The turbine is coupled to the high speed pinion by means of a flexible coupling.

The gearing consists of two elements—the high-speed gear formed of the single high-speed pinion driving two double helical wheels and arranged so that the high-speed pinion is balanced, the low-speed gear consisting of two pinions driving a single double helical wheel which is bolted to the propeller shaft.

The propeller shaft is arranged to run at 75 revolutions per minute, so that the total reduction from the turbine to the propeller is 30.6 to 1.

The pinions of all the gears are made of chrome nickel steel and the wheels of high carbon steel. The teeth are accurately cut and the parts carefully adjusted so as to insure a uniform transmission of the power over the whole surface of the teeth, and to allow for the necessary self-adjustment between the different parts of the gear. The gears are mounted in a strong cast iron casing with removable bushings lined with white metal and all parts are enclosed, so as to be perfectly oiltight and dustproof. The running parts are supplied with forced lubrication, the delivery and return pipes being of ample size.

Two duplex pumps are supplied for pumping the oil to the bearings and duplex pumps for circulating the water through the oil cooler. The oil cooler is of the Schutte & Koerting type and is of ample capacity, so that the bearings will be kept reasonably cool in any climate. This machinery was manufactured by the General Electric Company at their Schenectady (N. Y.) works.

The propeller is of the built-up type with cast iron hub and four manganese bronze blades with a diameter of 17 feet 6 inches and a designed pitch of 16 feet 3 inches (adjustable). The developed area is 121.5 square feet.

Steam is supplied at a working pressure of 190 pounds per square inch by three cylindrical boilers of the return tube type, each 14 feet 2 inches inside diameter and 11 feet 10 inches long over heads. The boilers have a total heating surface of 7,410 square feet and a grate surface of 165 square feet. They are arranged for burning coal and the furnaces are supplied with heated air. The blowers are arranged in the engine room and the air is brought through trunks over the top of the boilers and through the heating tubes down to the furnace fronts.

Propelling Machinery of the Cubadist

The propelling machinery of the *Cubadist* consists of a single three-cylinder triple expansion reciprocating engine, with cylinders 25 inches, 41 inches and 68 inches diameter by 48 inches stroke, designed to develop 2,100 indicated horsepower at 70 revolutions per minute, with a steam pressure of 185 pounds per square inch. The cylinders are arranged in the following order from forward to aft: high pressure, intermediate pressure and low pressure.

The engine is mounted on a cast iron box type bed plate of three sections and the cylinders are supported by six cast iron columns of box section. Six main bearings for the crankshaft are provided, lined with white metal. The bearing caps are of forged steel and the lower bearings can be removed without disturbing the crankshaft.

The crankshaft is built up of forged steel in three interchangeable reversible sections, with a diameter of 13¾ inches at the bearings. The crankpins are 14 inches diameter by 14 inches long. The crank slabs are 25¾ inches wide by 9½ inches thick. The coupling flanges are 27 inches diameter by 3¼ inches thick. The thrust shaft is 13¾ inches diameter at the ends and 14 5/16 inches diameter at the collars, of which there are nine, each 20½ inches diameter and 1⅞ inches thick. The propeller shaft is 14 13/16 inches diameter, with a composition sleeve fitted complete throughout the length of the shaft. All of the couplings are 26 inches diameter by 3¼ inches thick.

The high pressure cylinder is fitted with a liner and has a piston valve 13 inches diameter, taking steam in the middle and exhausting over the ends. The intermediate pressure cylinder is fitted with two piston valves, each 13 inches diameter, taking steam over the ends, while the low pressure cylinder is fitted with a double-ported slide valve, working on a cast iron false seat. The high pressure and intermediate pressure valves are fitted with balance cylinders and pistons of the ordinary type. The low pressure valve is fitted with a Lovekin patent assistant cylinder and is fitted with a balance ring at the back to relieve the pressure of the valve on its seat. The valve gear is of the Stephenson double-bar type.

The pistons are of cast iron of conical form, fitted with cast iron packing rings and cast iron followers. The piston rods are 6 inches diameter, while the tail rod of the low pressure cylinder is 4 inches diameter. The piston rods and valve rods are fitted with metallic packing. The crossheads are of forged steel and the crosshead slippers of cast iron lined with white metal. The crosshead pins are 7 inches diameter and 7½ inches long, and the connecting rods are of forged steel 9 feet long between centers, the top and bottom end boxes being of cast steel lined with white metal.

The engine is reversed by a direct acting steam cylinder 12 inches diameter by 18 inches stroke, with a 6-inch oil cushioning cylinder secured to the inside of the after back collar. The reverse shaft is 6½ inches diameter carried on the back columns. The turning engine consists of a 6-inch by 6-inch single cylinder at the after end of the main engine.

Condensing Plant

Steam from the low pressure cylinder is exhausted through a copper pipe 21 inches diameter to a Weir type main condenser, carried on cast brackets secured to the two after back columns of the engine. The shell of the condenser is of steel plate with water chests of cast iron and the tube sheets of rolled brass. There are 1,535 ¾-inch outside diameter tubes, No. 17 B. W. G. thick, 10 feet long between tube sheets. The total cooling surface of the condenser is 3,011 square feet.

The main air pump is of Blake & Knowles vertical wet and dry twinplex beam type, 12 inches by 22 inches by 22 inches by 15 inches, with a single steam cylinder. The main circulating pump is of the Fore River centrifugal double suction type with 14-inch suction and discharge connections, driven by a 9-inch by 9-inch engine.

An auxiliary condenser of 800 square feet cooling surface is also provided. The shell is cylindrical and of steel plate, the water chests of composition, and the tube sheets of rolled brass. There are 554 ¾-inch outside diameter No. 17 B. W. G. tubes, 7 feet 4½ inches long between tube sheets. The air and circulating pump is of the horizontal type, 10 inches by 12 inches by 12 inches by 12 inches, located in the engine room and supporting the condenser.

Auxiliary Machinery

Two feed pumps, 10-inch by 7-inch by 24-inch vertical simplex.

One ballast pump, 16-inch by 10-inch by 18-inch horizontal duplex, located in the pump room.

One deck service and sanitary pump, 6-inch by 6-inch by 6-inch horizontal duplex, located in engine room.

One fresh water pump, 3½-inch by 3½-inch by 4-inch horizontal simplex, located in engine room.

One fire and bilge pump, 9-inch by 5¼-inch by 10-inch horizontal duplex, located in engine room.

One brine circulating pump, 3-inch by 2¾-inch by 3-inch horizontal duplex, located in engine room.

One refrigerating circulating water and evaporator feed pump, 4½-inch by 3¾-inch by 4-inch horizontal duplex, located in engine room.

One cargo pump, 18-inch by 12-inch by 18-inch horizontal duplex, located in pump room.

One forward bilge pump, 8-inch by 8-inch by 12-inch horizontal simplex, located on flat above fore peak.

All reciprocating pumps are of the Blake & Knowles Manufacturing Company's make.

Two 2¾-inch Hancock injectors for main boilers.

One injector for hot water to fire main for washing out cargo tanks.

Ash hoist, Crompton type, located on forward bulkhead of fire room. Operating self-dumping buckets in starboard ventilating trunk.

The forced draft blowers, manufactured by the B. F. Sturtevant Company, are located in the engine room at the upper grating level and have a capacity of 24,000 cubic feet of air per minute at 400 revolutions per minute, operating at a reduced steam pressure of 130 pounds per square inch.

The forced draft heaters, which are located in the uptakes at the front of the boilers, consist of 198 tubes for each boiler, 3¼ inches outside diameter, 3 feet 6¼ inches long.

A Reilly feed water heater of the exhaust type is located in the engine room and on the discharge side of the feed pumps. There is also an evaporator of the Griscom-Russell Manufacturing Company's make, of 12 tons capacity per 24 hours, located in the engine room.

The refrigerating plant consists of two Brunswick machines of 2 tons capacity each (in duplicate) and an ice-making tank of 500 pounds capacity in twelve hours.

The electric lighting plant consists of two 15 kilowatt direct connected General Electric Company marine generating sets, with combined generating and distributing switchboard. The distribution is on the two-wire system and supplies current for one 18-inch searchlight and 150 16-candlepower incandescent lamps in addition to running and signal lights. A wireless telegraph outfit is installed in the bridge house.

Lifesaving Equipment

The lifesaving outfit consists of two 24-foot wooden lifeboats, one 16-foot wooden dinghy and one 20-foot wooden gig fitted with a gasoline (petrol) engine. The lifeboats are handled by Martin Freeman compensating davits and the dinghy and gig by bar type davits.

The steering gear is of the Brown steam tiller type, with a 7½-inch by 12-inch engine operated by telemotor from pilot house and the top of the pilot house and by shafting and bevel gears from the top of the poop deck house.

A No. 11 Hyde steam brake windlass is located on the forecastle deck, operated by a worm and spindle from a vertical 12-inch by 12-inch engine on upper deck. Wildcats are provided on the windlass suitable for 2¼-inch diameter stud link anchor chain.

Three Hyde double cylinder, double drum, reversible steam hoisting winches with cylinders 8 inches diameter by 8 inches stroke are located on deck for cargo-handling purposes. Two of these winches are fitted with extended warping ends.

A Hyde special capstan and double-headed gypsy is located aft on poop deck, consisting of a steam-driven capstan driven by an 8-inch by 8-inch engine under the poop deck. This engine is also arranged to drive by shafting, worms and pinions two nigger heads located on the poop deck about 12 feet on each side of the capstan.

On the trial trip of the *Sucrosa,* which took place on June 30, 1916, the machinery operated to the entire satisfaction of the owners' and builders' representatives, and the gears were practically quiet, while the operation of reversing was perfectly easy.

An examination of the gears after the trial showed that the teeth had a good bearing over the whole surface, and the smooth running of the gears and bearings promised a very satisfactory installation.

The *Sucrosa* is a sister ship to the *Cubadist,* which is fitted with reciprocating engines, and the two vessels as regard the hull, propellers, condensing apparatus, boilers and auxiliary machinery, also the method of loading, length of voyage, etc., are identical, so that comparative data between the reciprocating and turbine reduction gear machinery, now being taken by both shipbuilders and owners, should prove of exceptional interest and value.

Large Italian Freighter with Special Equipment for Unloading Cargo

The freight steamer *Milazzo,* built for the Navigazione Generale Italiana by the Fiat-San Giorgio Company, of Muggiano, near Genoa, Italy, arrived in New York on July 1 on her maiden voyage. This vessel is 511 feet 10 inches long overall; 65 feet 7½ inches extreme beam, and 34 feet depth at the side with a load draft of 26 feet. Her displacement at full load is 20,040 tons; gross tonnage 11,477; net tonnage, 7,537, and deadweight capacity,



Italian Freighter *Milazzo*

14,240 tons. She is capable of a speed of 11 knots and is propelled by a single screw driven by a quadruple expansion engine of 4,000 indicated horsepower.

Besides being a cargo carrier of unusual size, special interest in this vessel centers in the arrangements for discarding bulk cargo. Under the main cargo holds, of which there are six, is a double bottom which in section resembles the letter "W." Running beneath the double bottom, midway on each side of the holds, are galleries in which small cars are run on tracks. These cars are automatically loaded by gravity through doors cut in the sloping bottom of the holds over the galleries; then the loaded cars are hoisted through vertical elevating shafts above deck and discharged overside through hoppers and chutes. In all there are twenty of these elevators operated by steam winches. For cargo other than bulk cargo the usual methods of loading and discharging through centerline hatches are employed.

This system of unloading bulk cargo is the invention of Captain C. E. Manada, and elevators of the Menada type have previously been installed on lighters in Italian and South American ports.

TANK STEAMER EQUIPPED WITH WESTINGHOUSE GEARED TURBINES

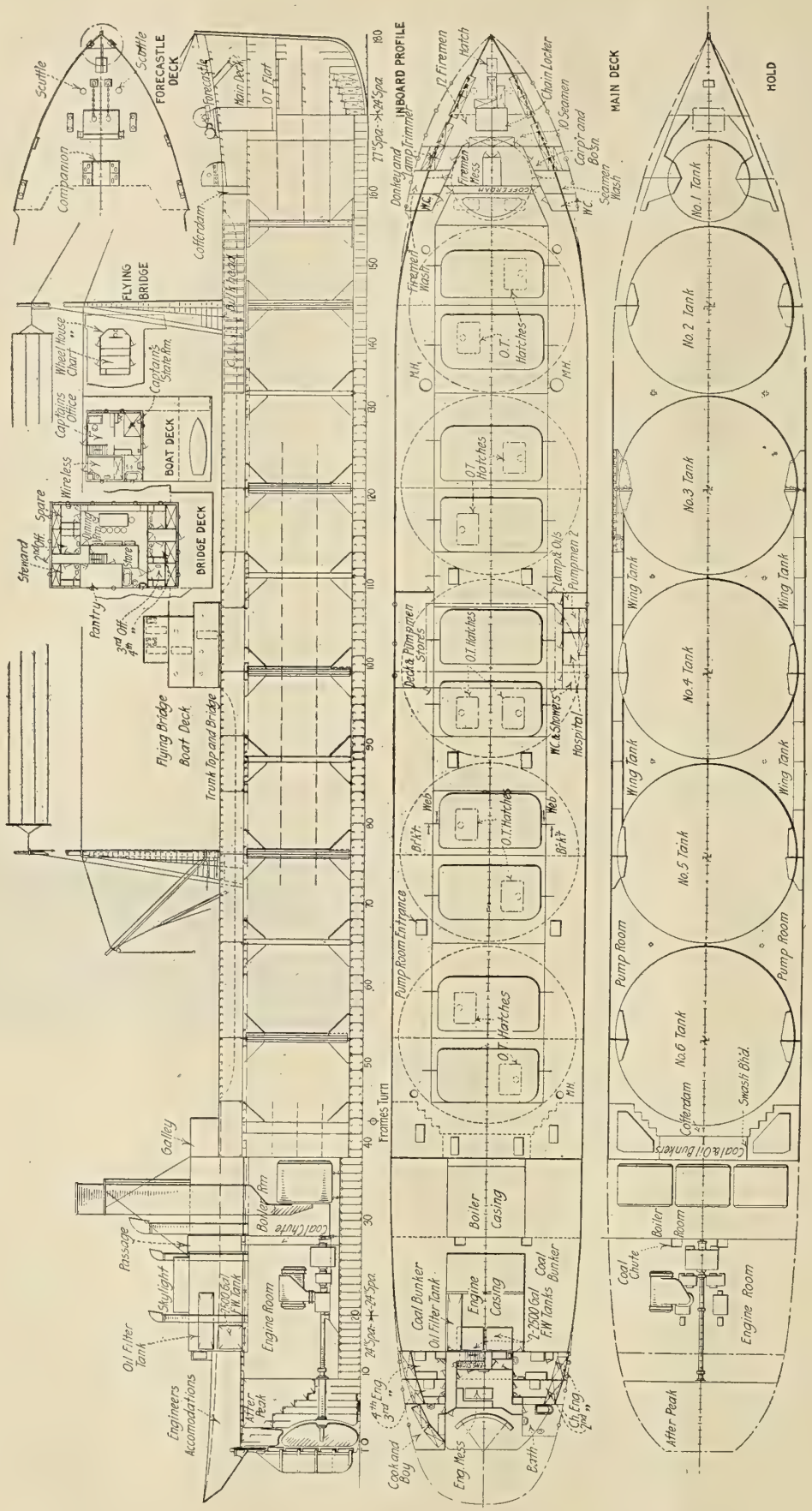


Fig. 1.—Inboard Profile and Deck Plans

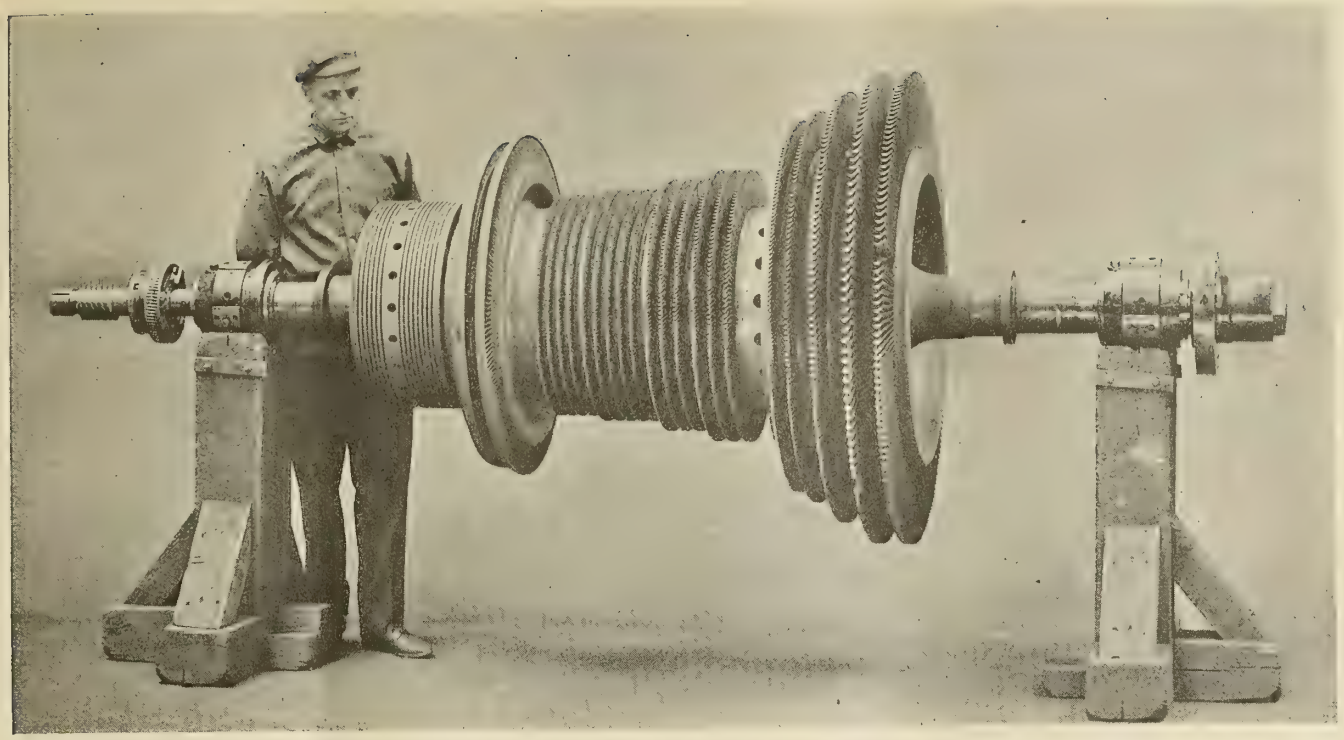


Fig. 2.—Impulse Reaction Turbine Spindle showing Blading, Dummy, Main Bearings, Thrust Bearing, Governor Drive Gear and Flexible Coupling

Westinghouse Geared Turbine Machinery for Single Screw Tank Steamer

Cross Compound, Double Reduction Type Turbine Drive—Entire Equipment of Main and Auxiliary Machinery of the Rotary Type

FOURTEEN large tank and freight steamers which represent the latest developments in machinery and hull construction, are unter construction at the yards of the Chester Shipbuilding Company, Chester, Pa. One of these vessels, described below, is of the following dimensions:

Length	401 feet
Beam	54 feet
Draft	25 feet 9 inches
Displacement	12,650 tons
Cargo capacity	9,000 tons

The vessel is designed to carry oil. The main tanks are cylindrical and between them and the ship's side are formed the wing tanks as shown in Fig. 1. By this construction the bulkheads are cylindrical in form and hence the surface subjected to liquid pressure is concave, which gives greater strength for the same weight. The use of this construction permits considerable reduction in the weight of the bulkhead structures.

The propelling machinery is located in the stern and consists of three single-end Scotch boilers and geared turbines for driving the single propeller. The boilers are equipped with forced draft and have a heating surface of 8,860 square feet.

Propelling Machinery

The propelling machinery is to be supplied by the Westinghouse Machine Company, of East Pittsburgh, Pa., and will be of their geared turbine type, arranged as shown in Fig. 3. The unit, which is of the cross compound, double reduction type, is composed of a high and a low pressure turbine, two single pinion first reduction gears and one double pinion second reduction gear.

The ahead high pressure turbine is composed of a two row impulse wheel followed by reaction blading on a drum. The ahead low pressure turbine is of the reaction type. The astern high pressure and low pressure turbines are two row impulse wheels. In both ahead and astern turbines the steam passes successively through the high and low pressure turbines.

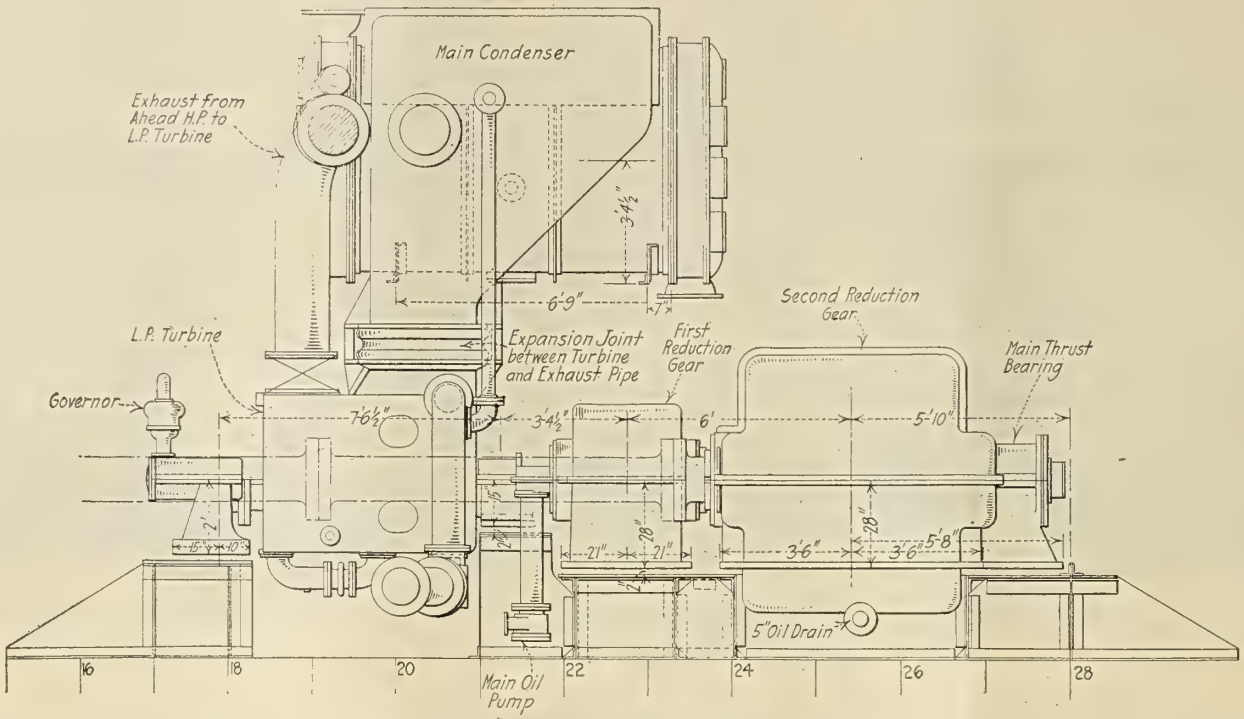
The reduction gears are of the double helical floating frame type. The first gears are provided with hydraulic dynamometers for the measurement of power and drive rotary oil pumps which supply lubricating oil to the unit. A Kingsbury main thrust bearing is contained in the forward end of the second gear.

The admission of steam to the ahead and astern turbines is controlled by two balanced throttle valves, both of which are contained in one body and operated by the same hand wheel. The piping and valves are arranged so that in addition to the normal cross compound operation, either the high pressure or the low pressure ahead or astern turbines can be operated independently in case of emergency, the turbines being controlled by the main throttle valves in all cases.

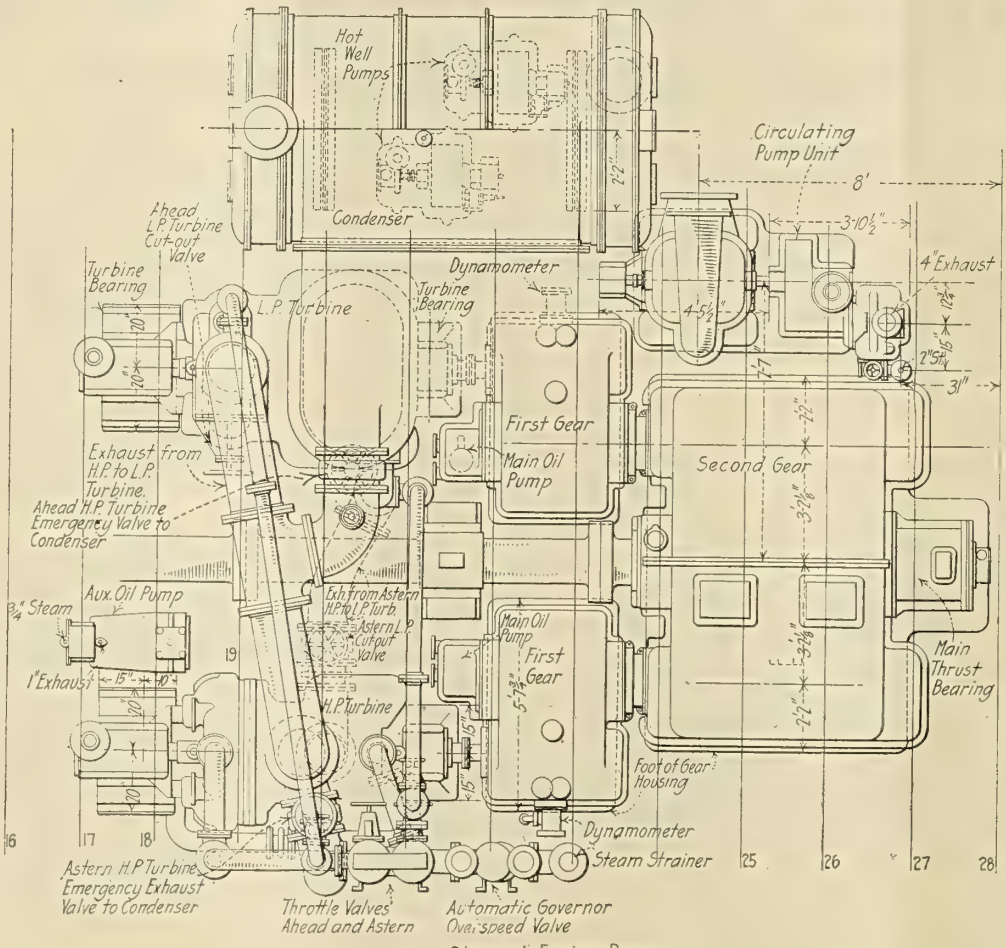
The condensing plant, which is designed for high vacuum, is composed of a steel plate surface condenser, a geared turbine driven centrifugal circulating pump, two

ARRANGEMENT OF PROPELLING MACHINERY

(Fig. 3)



Elevation Looking to Port



Plan of Engine Room

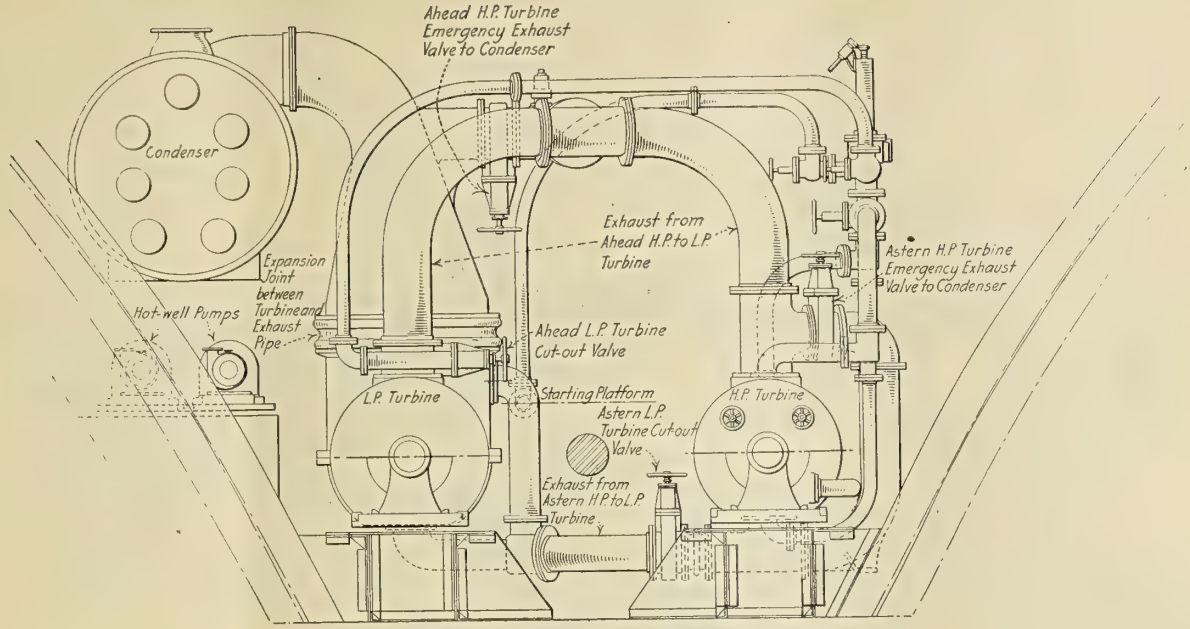


Fig. 4.—Cross-Section Through Engine Room

turbine driven centrifugal hot well pumps, and two Leblanc air ejectors.

The lubrication of the main turbine bearings, the gear teeth and bearings is effected by a continuous circulation of oil through a gravity system composed of delivery and return piping, pumps, cooler, strainer and tank.

The turbine and gear foundations are of the usual plate and angle construction built up from the engine room floor as shown.

The ship is designed for a normal speed of 10¾ knots and for a maximum of 11½ knots, on a displacement of 12,650 tons, the designed performance data being as follows:

Speed, knots	10.75	11.5
Revolutions per minute, propeller	70	75
Revolutions per minute, turbine	3,600	3,860
Shaft horsepower	2,500	2,900
Shaft horsepower, astern	1,500	1,740

The astern turbines will develop 60 percent of the ahead power with the same flow of steam. Steam will be supplied to the turbines at a pressure of 180 pounds gage, and the condensing plant is designed to maintain a vacuum of 28½ inches of mercury.

The machinery weights are as follows:

Turbines, steam piping and valves	17.9 tons
Gears, thrust bearings and oil pumps	34.0 tons
Condenser	11.6 tons
Condenser auxiliaries	3.6 tons
Oil system	1.6 tons
Total	68.7 tons
Total	61.5 pounds per shaft horsepower

Turbines

The turbines are of the Westinghouse impulse reaction cross compound type, as illustrated in Figs. 5 and 6. At full power the turbines are designed to develop 1,250 horsepower each, or a total of 2,500 horsepower at a speed of 3,600 revolutions per minute.

The turbine cylinders are made of cast iron, except the ahead end of the high pressure turbine, which is of cast steel, and are divided on the horizontal plane. The main bearing pedestals at the exhaust ends are cast integral with the lower halves, while at the inlet ends the main and thrust bearing pedestals, which also carry the governors, are cast separately and bolted on. Feet are cast on the exhaust end of the cylinder, and at this end the cylinder is bolted to the foundations. At the forward end the bearing pedestal is supported on a cast steel sole plate which is bolted to the foundations. Slides are bolted to this sole plate to allow the freedom for expansion of the turbine cylinder in a fore and aft direction.

The ahead high pressure nozzle chamber is contained in the end of the cylinder casting, which is made of cast steel to withstand the high pressure and temperature. The astern high pressure nozzle chamber is a separate steel casting bolted inside of the cylinder. The astern low pressure nozzle chamber is of the same construction, but is made of cast iron. The ahead low pressure nozzle chamber is formed in the cylinder as shown. The nozzle chambers in the upper and lower parts of the cylinder (except the ahead low pressure) are separate, each being provided with its own inlet and steam pipe.

The shafts and rotors are made of forged steel. The impulse wheels are formed integral with the shafts and the parts of the rotor are bolted together on a large diameter. The length between bearings is made short and the construction exceedingly stiff to obtain smooth and safe operation.

The high pressure ahead and astern and the low pressure astern nozzles, which are of the divergent type, are cast in bronze and secured to the nozzle chambers as shown. The upper high pressure ahead nozzle chamber is divided into three compartments, two of which are provided with hand operated valves for closing off part of the nozzles at reduced power. With this arrangement of group control, all, five-sixths or three-fourths of the nozzles can be in operation as required. The astern nozzles are not arranged for group control because economy at reduced astern power is of little importance.

LONGITUDINAL SECTIONS OF MAIN TURBINES

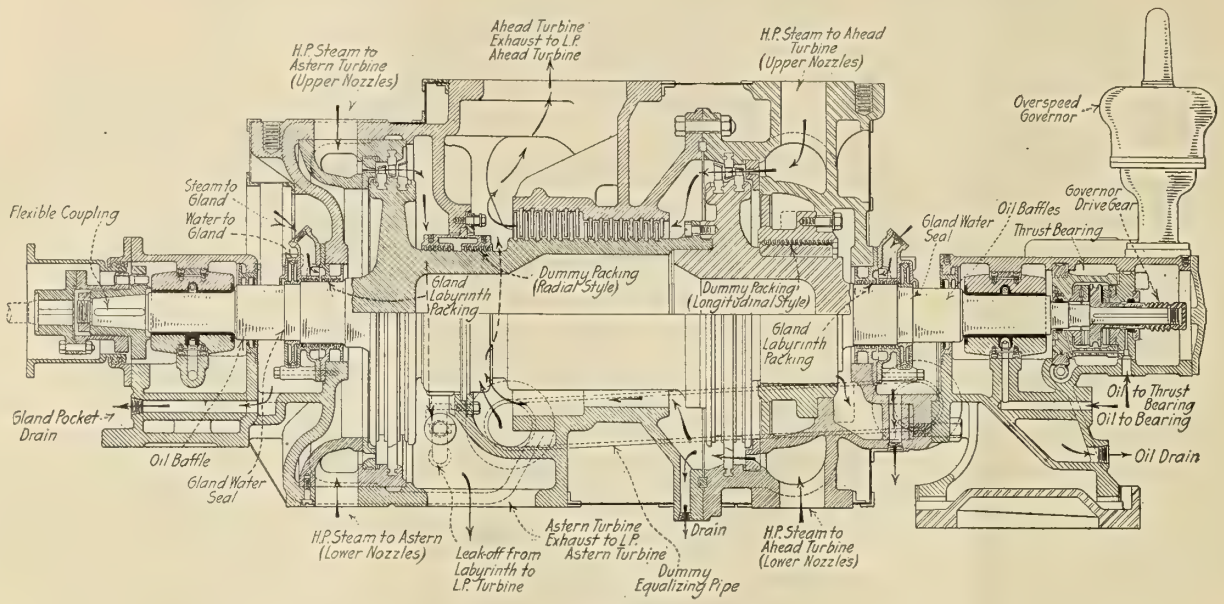


Fig. 5.—High Pressure Turbine

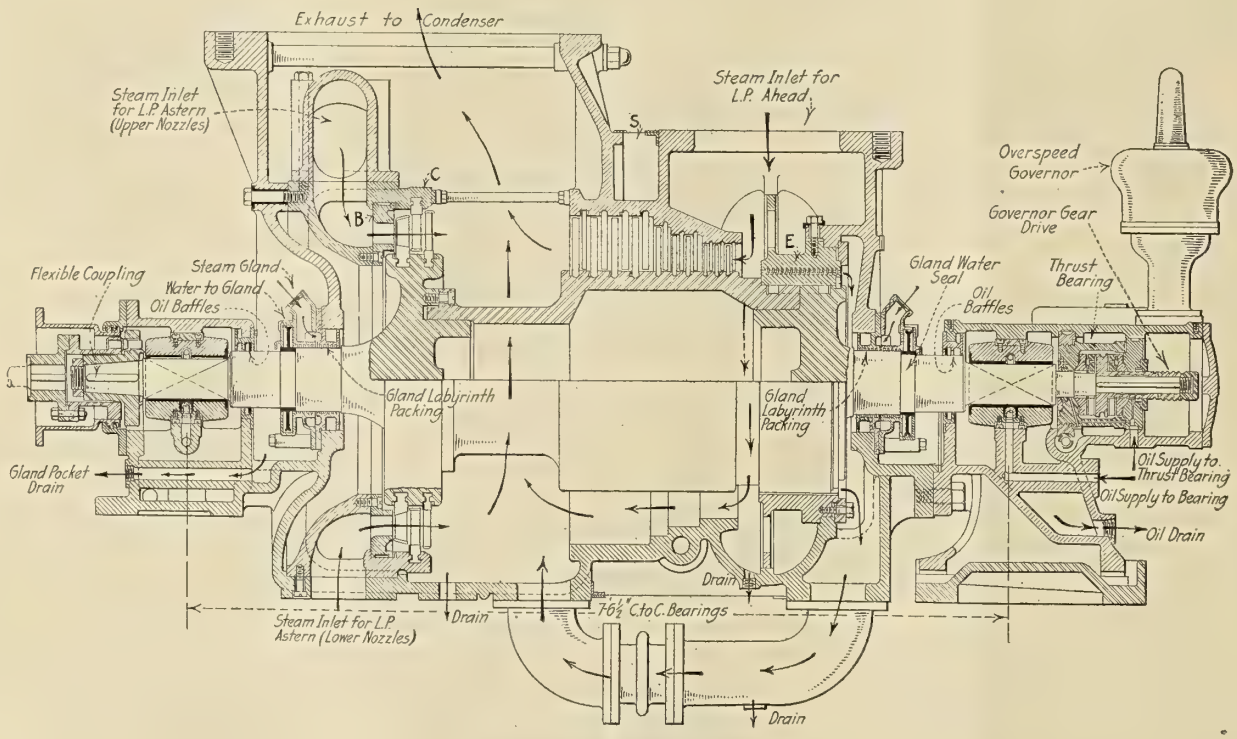


Fig. 6.—Low Pressure Turbine

BLADING

The impulse blades are made of machined nickel steel. They are secured in the rotor by a tongue and groove construction, and also are additionally secured against vibration by being tightly wedged in the groove. The tips of the blades are secured by a binding strip which is inserted in a groove and welded. This construction is unusually strong and rigid.

The reaction blading is made from drawn phosphor bronze. As shown in Fig. 7, the foot which is formed on the end of the blade fits under the packing piece, forming a positive interlock which holds the blade securely. The blade groove is under cut and provided with a groove in the floor of the main groove for the reception of the feet of the blades. The blades are secured at their outer radius by a comma lashing wire which is passed through them near the ends, sheared and clinched and silver soldered. An important feature in this blading construction

is that the blade section is tapered, being thicker at the root than at the tip for the purpose of equalizing the stresses.

Balance pistons are located at the inlet ends of the ahead high pressure and low pressure turbines to balance partially the steam thrust on the drums. The stationary part, which carries aluminum strips, is made in halves and bolted to the cylinder as shown. Balance pipes connect the spaces behind the dummies with the exhaust from their reaction blading.

Labyrinth Packing

A packing of the radial labyrinth type is located between the high pressure ahead and astern turbines. The stationary part is made of bronze and held in the partition by a spring ring as shown. The packing strips are made of special composition, and are held out against shoulders in their grooves by flat springs. Between the strips there are baffles on the rotor to interrupt the flow. An annular leak off chamber which is connected with the last expansion of the low pressure turbine is provided to utilize part of the leakage from the exhaust chamber.

The glands are composed of steam sealed labyrinths and water seals. The labyrinth is of the radial type, the strips being held out against shoulders in the groove by flat springs. The steam gland is sealed from an annular chamber and port as shown. The water seal operates on the principle of a centrifugal pump. The impeller is provided with radial paddles or ribs, and revolves in a chamber which is supplied with water at the periphery of the impeller. The centrifugal action of the paddles on the water causes it to revolve and to form a ring of water under considerable pressure in the chamber, which gives a perfect seal against passage of air into or steam out of the turbine. The water seal is designed to operate from full to half speed. Below the latter speed the centrifugal force is not sufficient to maintain the seal, and therefore, from stop to half speed, it is necessary to use the steam sealed labyrinth. The steam seal will, therefore, be used when steaming at very low speed, maneuvering and standing by.

Steam is supplied to the glands from the main steam line through a reducing valve which regulates the pressure to about 5 pounds gage, as shown in the diagram Fig. 9. Water is supplied to the glands from a gravity tank into which the discharge of the condensate pump is led before passing to the feed tank, as shown in Fig. 10. The tank is located about 12 feet above the glands, which gives a pressure of about 5 pounds. The steam and water to the glands are led through valves which are operated by the maneuvering valves so that the water is shut off and the steam turned on automatically in case the turbines are slowed down suddenly.

The main bearings are of the self-alining type and are provided with pads and liners, by means of which the rotor can be adjusted vertically and horizontally. The body is made of cast iron and the lining of white metal. Oil is supplied through the bottom pad and is led up to a distributing groove in the top of the bearing. Felt wipers are provided around the shaft to exclude dirt.

The thrust bearing is of the Kingsbury segmental type, and is provided with means for moving the rotor endwise for adjusting the dummy clearances. This is accomplished by a nut which works on threads on the body of the bearing and is revolved in a groove in the turbine casing by a hand-operated worm, which is turned by a hand wheel.

Oil from the supply piping is supplied to the bearings at a pressure of about 5 pounds through the channels shown, and after having passed through the bearings, it drains into the wells, and thence passes into the drain piping.

The turbine shaft is connected to the flexible shaft of the pinion by means of a pin coupling which permits the pinion to move endwise. Provision is made for lubricating the pins and bushings.

An emergency overspeed governor is located forward of the thrust bearing, and is driven from the turbine shaft by spiral gears at 24 percent of the speed of the turbine, or at 857 revolutions per minute for the full speed. The governor is of the centrifugal type and controls the governor valve in the main steam line by means of a steam relay. The floating lever and pilot valve are located on the governor. Steam from the pilot valve is piped to the relay cylinder which operates the governor valve, and the motion of the latter is transmitted back to the floating lever through shafts and rods.

The hot portions of the turbine cylinders are lagged with non-conducting material, and the middle portion of

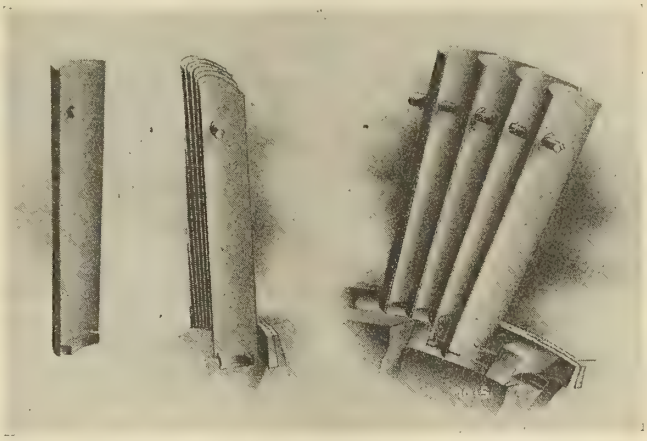


Fig. 7.—Construction of Reaction Blading, showing Hook at Base of Blade, Wedges and Comma Lashing

the cylinder is enclosed in a 1/16 inch sheet metal jacket, which is arranged for removal and for access to the turbine joints.

All pockets in the turbines and piping are provided with drains, which are led into a steam ejector which discharges the water into the condenser as the latter is located several feet above the drain levels. Relief valves are located on the ahead and astern receiver pipes.

The lifting gear is composed of I-beam girders and chain hoists above the turbines and gears, and special slings and guides are provided for lifting the rotors without injury to the blading. A hand ratchet lever which operates on ratchet teeth cut on the flange of the coupling is provided for turning the turbine.

All pipe connections to the turbines are designed to allow free expansion without imposing stress on the turbine cylinders. The turbine will be tested to 20 percent above the designed full speed, or to 4,320 revolutions per minute.

Turbine Valve Gear and Steam Piping

The arrangement of the turbine steam valves and piping is shown in Fig. 3, and diagrammatically in Fig. 8. Fig. 11 shows the valve group, which is composed of a steam strainer, governor valve and ahead and astern maneuvering valves.

The steam strainer has a cast iron body and perforated steel cylindrical strainer.

The governor valve is of the double disk balanced type

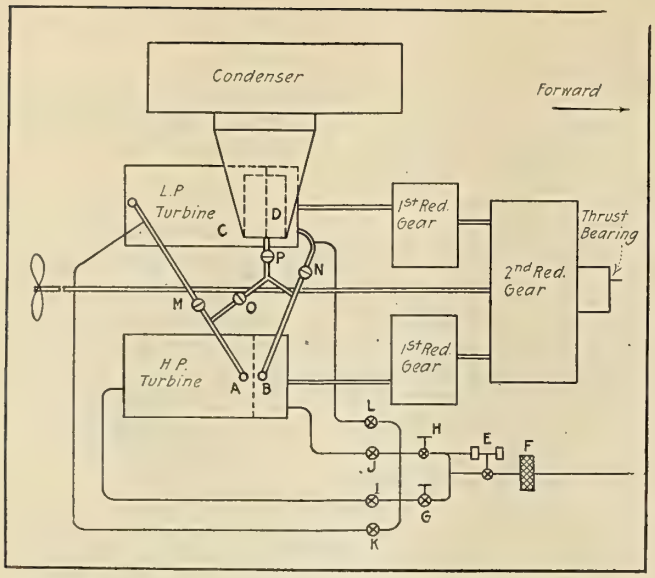


Fig. 8.—Diagram showing Steam Piping and Valves of Main Turbines

A, high pressure ahead turbine; *B*, high pressure astern turbine; *C*, low pressure ahead turbine; *D*, low pressure astern turbine; *E*, automatic governor overspeed valve; *F*, steam strainer; *G*, ahead throttle valve; *H*, astern throttle vale; *I*, high pressure ahead turbine cut-out valve; *J*, high pressure astern turbine cut-out valve; *K*, emergency steam valve to ahead low pressure turbine; *L*, emergency steam valve to astern low pressure turbine; *M*, ahead low pressure turbine cut-out valve; *N*, astern low pressure turbine cut-out valve; *O*, ahead high pressure turbine emergency exhaust valve to condenser; *P*, astern high pressure turbine emergency exhaust valve to condenser.

operated by two steam relay pistons through a yoke. The operation of the relay pistons and the opening and the closing of the valve are controlled by the turbine governors and pilot valves as previously described. The high pressure turbine governor controls one of the relay cylinders and the lower pressure governor the other. The operation of either cylinder will close the valve. Under normal operating conditions the governor weights are held in against their stops and the valve is wide open. Should the speed of either turbine element reach the overspeed for which the governor is set, the weights move out and cause the valve to close sufficiently to prevent further increase in speed. With this arrangement, the turbine is not shut down completely and is always under direct control of the maneuvering valves.

The ahead and astern maneuvering valves are contained in a single cast steel body, and are of the balanced single disk type with a pilot valve on the valve stem for automatically equalizing the pressure in opening. Springs are provided above the valves to prevent them from chattering in the current of steam. The valves, balance cylinders and pilot valves are of bronze. Both valves are operated by a single hand wheel which operates through shafts, bevel gears and a screw, the yoke which lifts the valves against the compressions of their springs are shown. In the stop position both pilot valves are held closed by their springs, and the main valves by the unbalanced pressures above the pistons. The automatic valves for the gland sealing steam and water are operated by cams attached to the yoke as shown.

The main high pressure steam piping is of steel, and the low pressure receiver piping between the turbines and the main exhaust pipe is of cast iron. A copper expansion joint is located between the turbine and exhaust pipe, and another in the astern receiver pipe.

Reduction Gears

The reduction gears are of the Westinghouse mechanical floating frame type as shown in Figs. 12 and 14. At

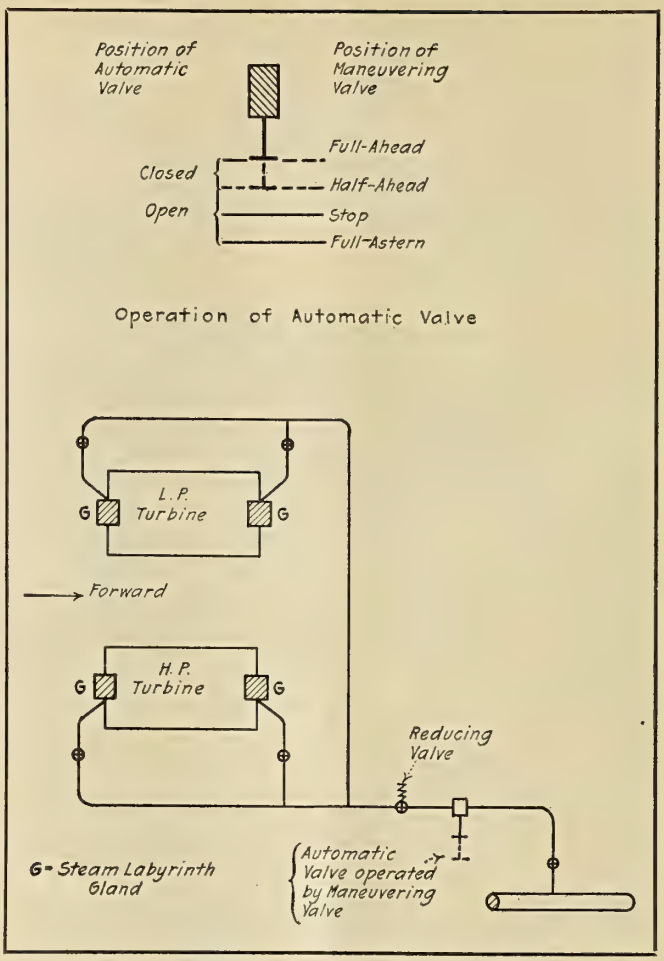


Fig. 9.—Diagram of Turbine Steam Seal Piping

the designed full power, the first or high speed gears reduce the speed from 3,600 to 450 revolutions per minute, the ratio being 8 to 1, and transmit 1,250 horsepower each. The second or low speed gears reduce the speed from 450 to 70, the ratio being 6.45 to 1, and transmit 1,250 horsepower per pinion, or a total of 2,500 horsepower. The total speed reduction from the turbine speed of 3,600 to the propeller speed of 70 gives a ratio of 51.4 to 1.

The gears are completely enclosed in an oil-tight cast iron gear box, divided on a horizontal plane. The gears are of the double helical type, the teeth being inclined at an angle of 30 degrees. The teeth are of involute form

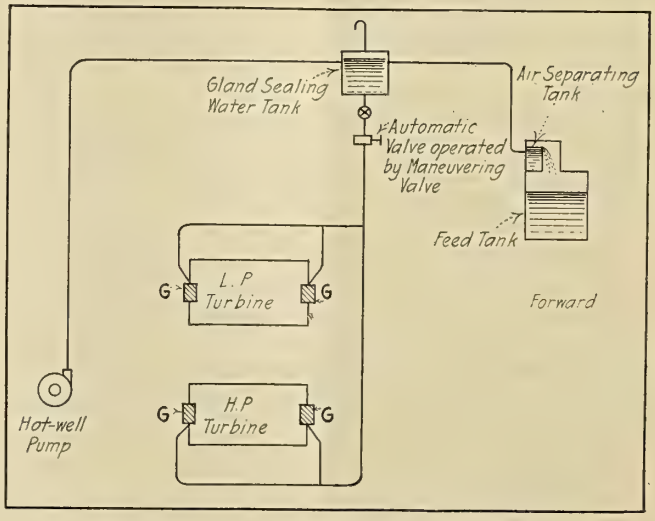


Fig. 10.—Diagram of Turbine Water Seal Piping

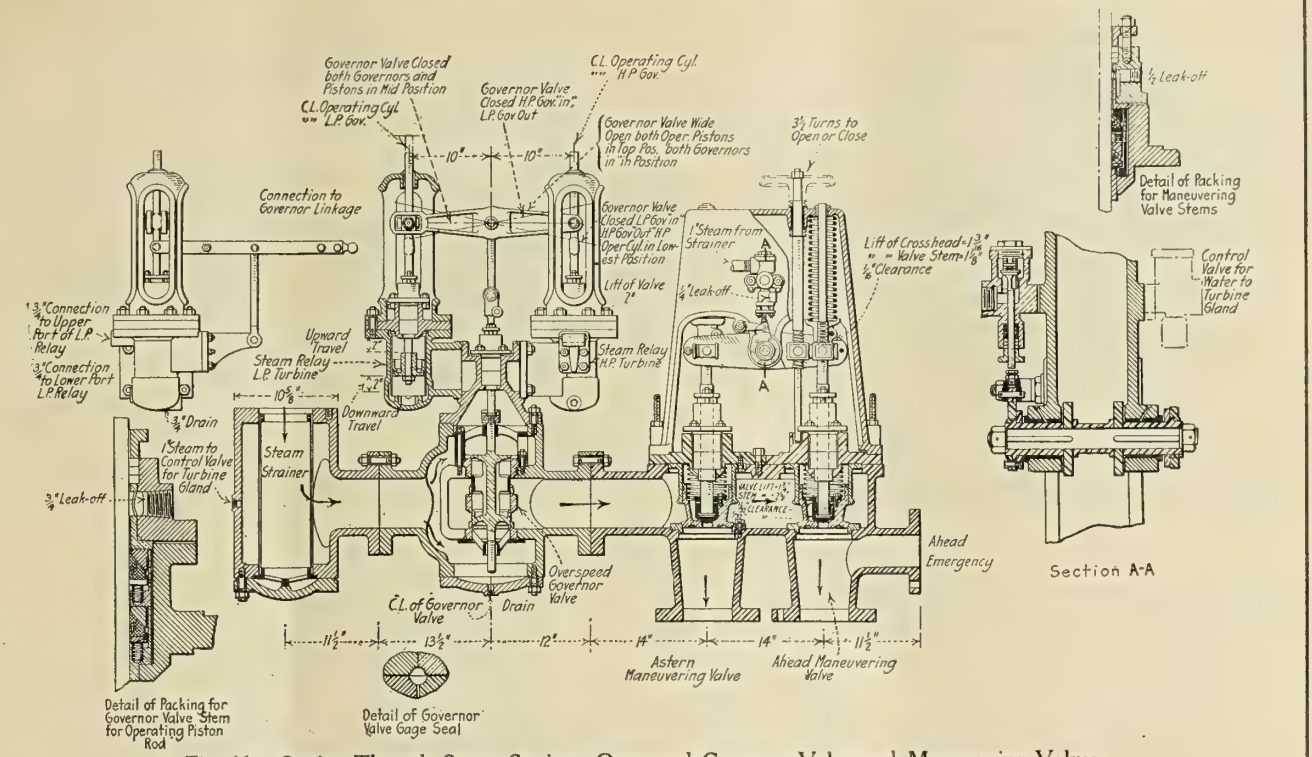


Fig. 11.—Section Through Steam Strainer, Overspeed Governor Valve and Maneuvering Valves

and are cut with utmost precision to obtain reliable and quiet operation.

The pinion is of the three bearing type and is carried in a heavy floating frame, which automatically maintains the alinement of the pinion and gear under all conditions of load, thereby producing uniform distribution of the pressure over the entire length of tooth face. The pinion is driven by a flexible shaft which extends through it and is secured to the end distant from the coupling. The flexible coupling permits the pinion to move endwise, and the flexible shaft permits it to tilt under the action of the teeth, bringing it into perfect alinement, thereby distributing the load across the entire length of tooth face. The uniform distribution of pressure at all loads permits the use of higher pressures and smaller pinions and gears than is the practice with rigid bearing gears.

The floating frames, which are of extremely rigid construction to avoid deflection, are supported by feet under the middle bearing. The support is sufficiently flexible to permit the required tilting in the vertical plane. The ends of the floating frame are held in the correct vertical plane (i. e., the pinion is held in the correct alinement with the gear horizontally) by horizontal struts or guides. The frames are divided and bolted together horizontally, a longitudinal channel for supplying oil to the pinion bearings and teeth being formed in the joint. The frames of the first gears are made of cast iron, and those of the second gear of cast steel.

The gear wheels are composed of a heavy forged steel shaft, a cast iron center and forged steel rims.

The gear and pinion bearings are composed of heavy cast iron bodies lined with white metal. The bearings are supplied with oil from longitudinal channels on the sides which are supplied from the channels shown. Oil under a pressure of about 5 pounds is supplied to the gear from the oil system. No oil piping or fittings are contained in the gear box. A trough which is supplied with oil from the channel in the floating frame, is provided for supplying oil to the teeth from above as shown. Oil is supplied to the teeth from below by sprays which are directed against the back of the pinion from the channel in the frame, the oil being carried around with the pinion and drawn in through the meshing teeth.

Hydraulic Dynamometers

Westinghouse hydraulic dynamometers for measuring the power transmitted are incorporated in the pinion frames of the first gear. The dynamometer is composed of two pistons, one above and one below, which seat on the gear box and operate in cylinders in the floating frame. Normally the feet of the frame are bolted securely to the gear box with long bolts which extend up through the cover, but when it is desired to measure the power these bolts are unscrewed sufficiently to permit the frame to float on the hydraulic pistons.

The hand control valve on the control arm of the frame is then opened, permitting oil to flow from the bearing into the cylinder, until the frame is raised from its seating slightly, which is indicated by the pointer on the control arm. (The pinion journal acts as a pump and supplies a considerable flow of oil under high pressure.) Since the frame is then supported by the oil pressure, the total pressure on the piston, corrected for the weight of the pinion and floating frame, represents the total pressure on the teeth, and this combined with the pitch line speed gives the horsepower transmitted by the gear. Or actually the gage pressure of the oil in the dynamometer cylinder, and the revolutions per minute, are observed, and after correcting the former, the power is obtained from their product multiplied by a constant. The sum of the power of both gears gives the total power transmitted to the propeller.*

* See footnote on page 374.

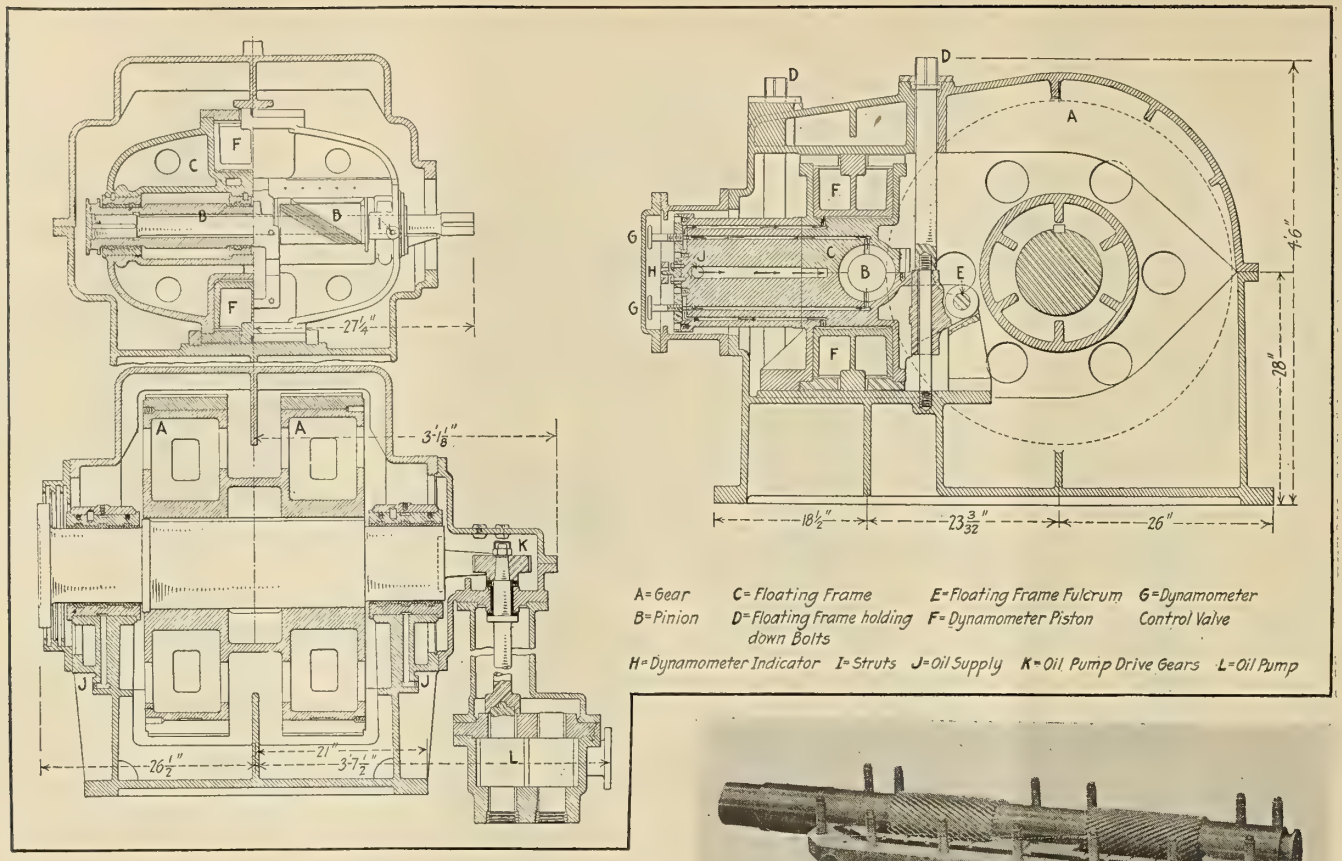


Fig. 12.—First Reduction Gear

KINGSBURY THRUST BEARING

A Kingsbury thrust bearing which takes the thrust of the propeller is located on the forward end of the second gear, as shown in Fig. 14. Since the thrust is transmitted to the ship's structure through the gear box, the necessity for an independent thrust block foundation is obviated. The bearing has a single collar which is secured to the gear shaft and revolves between two sets of segmental slippers. Each slipper is pivoted on a hardened seat which permits it to automatically assume the required position to distribute the load uniformly over the surface. The slippers are carried in a slipper ring with a spherical seat which permits the ring to assume the position required to distribute the load equally among the slippers. This uniform distribution of pressure over the entire bearing surface and the self-alinement of the slippers give perfect film lubrication, which permits the use of a considerably higher unit pressure than is used in ordinary thrust bearings, and also gives greater reliability of operation.

*

$$\text{S. H. P.} = \frac{P_t V}{33{,}000}, \text{ where}$$

$$P_t = A\,p = \frac{\pi}{4} d_c^2\, p \quad \text{and}$$

$$V = \frac{\pi\, d_D\, n}{12} = \frac{\pi\, d_D\, N\, R}{12}$$

$$\text{S. H. P.} = \frac{\pi^2\, d_c^2\, d_D\, R\, p\, N}{4 \times 12}$$

$$\text{But } \frac{\pi^2\, d_c^2\, d_D\, R}{48} = \text{Constant} = C.$$

$$\text{Hence S. H. P.} = C\, p\, N,$$

where P_t = total pressure between the teeth in pounds.
V = pitch line speed in feet per minute.
A = area of piston in square inches.
p = pressure on piston in pounds per square inch.
d_c = diameter of cylinder in inches.
d_D = diameter of pinion in inches.
n = revolutions per minute of pinion.
N = revolutions per minute of propeller.
R = reduction ratio.

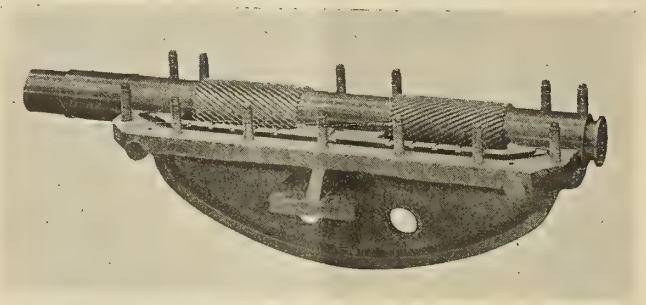


Fig. 13.—View of Pinion resting in Floating Frame, showing Bearings and Oil Supply Grooves to Pinion and Bearings. (Upper half of frame removed.)

The principal parts of the bearing are made of forged and cast steel and the slippers are lined with white metal. The bearing is lubricated by a continuous circulation of oil which is admitted near the bottom and completely fills the casing, the outlet pipe being led from the top of the casing into the gear box.

The revolution counter is driven by spiral gears on the end of the gear shaft.

As shown in Fig. 12, two oil pumps of the spur gear type are driven from the first reduction gears through spiral gears at a normal speed of 335 revolutions per minute. The pumps are located near the bottom of the drain tank and are provided with double suction and discharge valves so that they will pump with rotation in either direction—i. e., ahead or astern.

CONDENSING PLANT

The condensing plant* is of the latest Westinghouse type for producing the high vacuum required by turbines.

The condenser is of the steel plate type with cast iron heads, and is arranged for three passes of the cooling water. The tubes are ⅝ inch outside diameter and are 8 feet 6 inches long between the tube plates, the cooling surface being 4,500 square feet. With 65 degree cooling water, the condenser is designed to produce a vacuum of 28½ inches of mercury referred to a 30-inch barometer.

* A description of the Westinghouse-Leblanc air ejector system for producing high vacuum is given in MARINE ENGINEERING, December, 1915, in an article by Mr. G. L. Kothny, entitled "New Vacuum Apparatus."

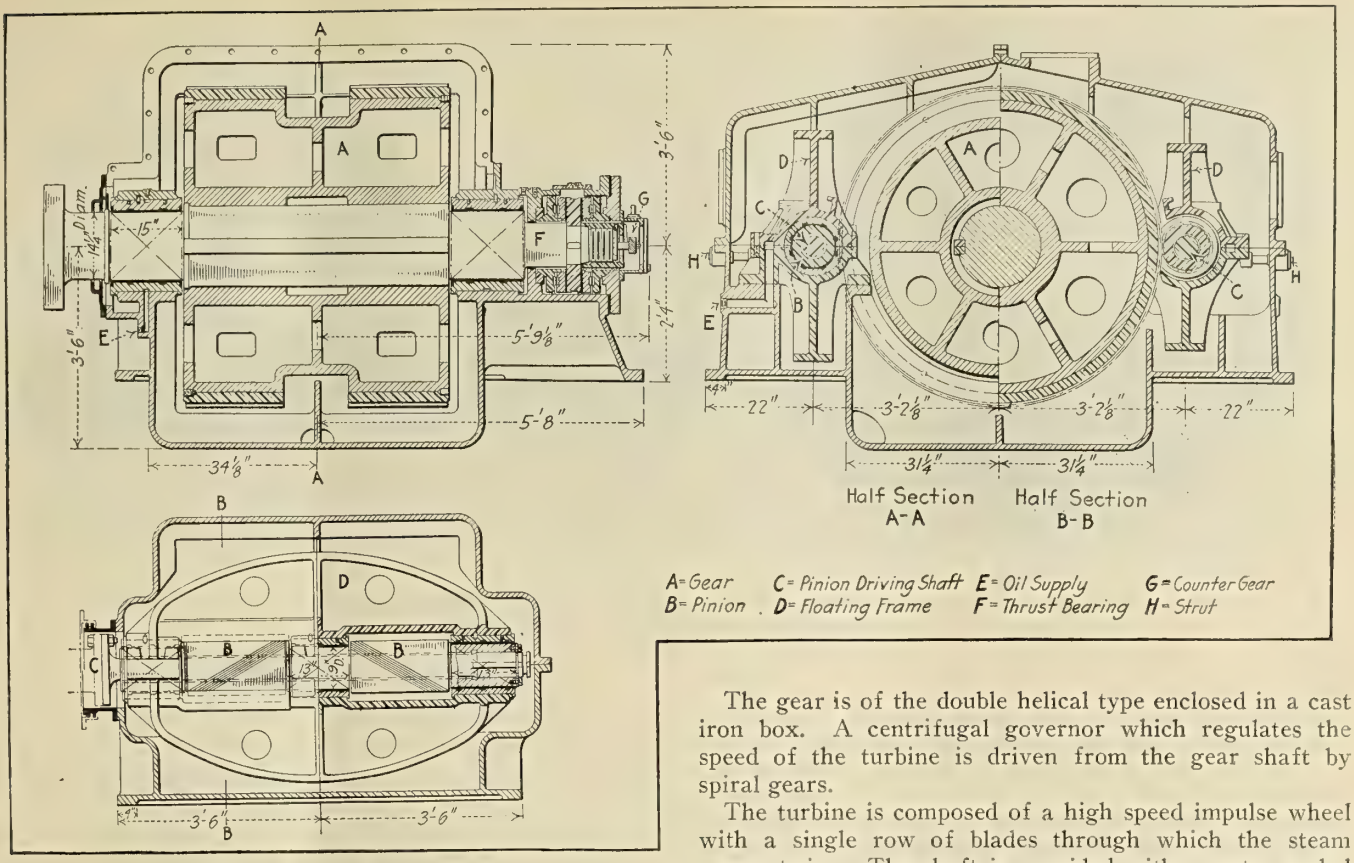


Fig. 14.—Second Reduction Gear

The circulating pump is of the single runner slow speed type designed for high efficiency, and is driven by a geared turbine unit, the revolutions of the pump being 550 and of the turbine 6,600. This gives a high efficiency for both pump and turbine, which results in a very economical unit. The pump has a capacity of 5,000 gallons per minute and requires 52 horsepower. When operating with 150 pounds of steam and 5 pounds back pressure, the estimated steam consumption is 2,340 pounds per hour, or 36 pounds per horsepower.

The pump body is of cast iron and is provided with a double inlet. The glands are packed with flax packing and are provided with water seals to prevent air leakage. The rotor is carried in two bearings, one on the gear and one on the pump body.

The gear is of the double helical type enclosed in a cast iron box. A centrifugal governor which regulates the speed of the turbine is driven from the gear shaft by spiral gears.

The turbine is composed of a high speed impulse wheel with a single row of blades through which the steam passes twice. The shaft is provided with a water sealed gland where it passes through the casing. At full speed, the speed of the turbine is regulated by the governor, which operates a balanced valve, the lower speeds being obtained by hand throttling.

The turbine bearings and reduction gear are supplied with a continuous circulation of oil from the main lubricating system, the gear teeth being lubricated by sprays.

There are two condensate or hot well pumps for withdrawing the condensate from the condenser. One pump is sufficient to serve the condenser up to maximum power, the second being provided as a spare for emergency use. The pumps are of the centrifugal type and are direct turbine driven. They are located below the condenser so that the condensate will drain into them by gravity. The water is discharged up into a small tank from which is taken the gland sealing water and from there it over-

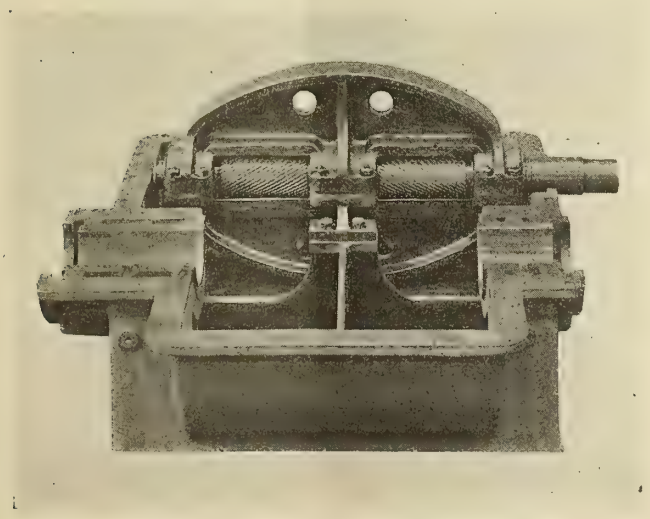


Fig. 15.—View of Pinion and Floating Frame in place in Gear Box. (Gear removed, Gear Bearings in place.)

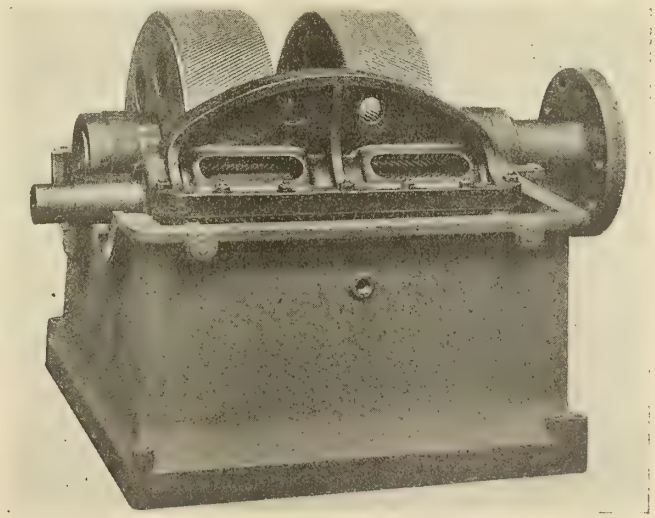


Fig. 16.—View of Gear with Cover of Gear Box removed, showing Floating Frame, Pinion and Gear

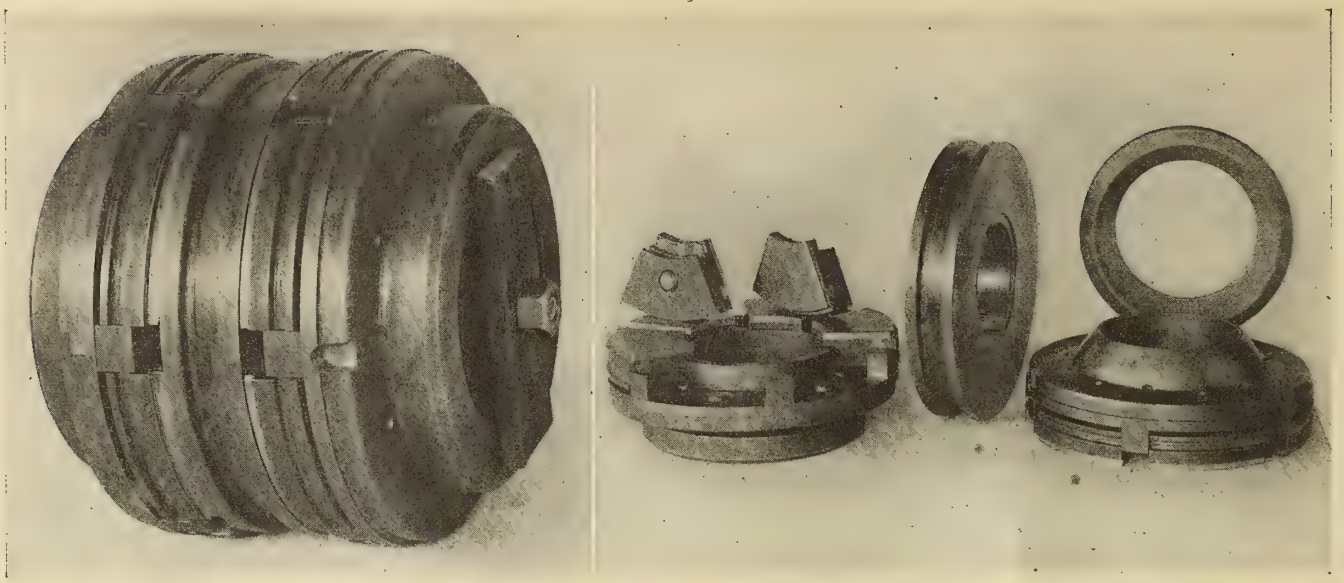


Fig. 17.—Views of Kingsbury Marine Type Thrust Bearing Assembled and Apart, showing Segmental Pivoted Thrust Slippers and Self-Alining Slipper Ring with Spherical Seat

flows to the air ejector tank, and thence passes into the feed tank. Each pump has a capacity of 50,000 pounds per hour and requires 6 horsepower. The revolutions per minute are 2,500, and the estimated steam consumption 650 pounds per hour.

The pump is of bronze and is of the single inlet type with a water sealed gland to prevent air leakage.

The turbine is of the impulse type with a single row of blades through which the steam passes twice. The casing is split horizontally and lagged and fitted with labyrinth type glands. The rotor is carried in two ring oiled bearings. The speed is regulated by a centrifugal governor, mounted on the turbine shaft, which operates a balanced governor throttle valve.

Westinghouse-Leblanc air ejectors are provided for withdrawing air from the condenser. There are two ejectors, one being sufficient for full load requirements, and the other being provided as a spare. The air is withdrawn by multiple jets of steam in series which compress it to atmospheric pressure. The mixture of air and steam passes into the air ejector tank, where the steam is condensed and the air escapes to the atmosphere. The air ejectors are made of bronze and the tank of steel plate. The estimated steam consumption is 1,760 pounds per hour for two ejectors, and the weight 97 pounds each.

Lubricating System

As shown in Fig. 18, oil is supplied to the gears and turbine under a pressure of about 5 pounds from a gravity tank. The oil first passes through a cooler, and is then supplied to the bearings and gear teeth, after which it drains back into the second gear box, and thence it passes into the drain tank. From the drain tank it passes into the oil pumps, which discharge it back into the gravity tank through the strainers located in the top of the tank. When the main units are in operation, the oil is pumped by the rotary pumps driven from the first gears. When stopped, running slowly, etc., the independently driven auxiliary oil pump is used.

The gravity, drain and storage tanks are of steel plate of rectangular form, and the piping is of galvanized iron. The cooler is composed of a nest of condenser tubes in a cast iron box. The cooling water passes through the tubes and is supplied from the main circulating pump. The auxiliary oil pump is of the Smith-Vail horizontal duplex steam piston type.

Distinctive Features of Machinery Installation

It is of interest to note that all of the machinery in this installation (except the air ejectors and auxiliary oil pumps) is of the rotary type, which embodies a number of novel and improved features for marine machinery.

The machinery weights are considerably less than is usual with reciprocating engines. The weight per shaft horsepower of the geared turbine installation is 61.5 pounds per shaft horsepower, or 56.5 pounds per indicated horsepower, whereas an engine installation would weigh about 110 pounds per indicated horsepower.

In general, the construction of the machinery is heavy and rugged, and ample precautions have been taken to obtain safety and reliability of operation throughout. There are two turbines which are arranged so that either turbine can be cut out and the other operated independently in case of emergency, thus guaranteeing safety against breakdown. The vessels could always proceed at reduced speed, and with backing power available. The main turbines are provided with safety overspeed governors which prevent the turbines from exceeding the maxi-

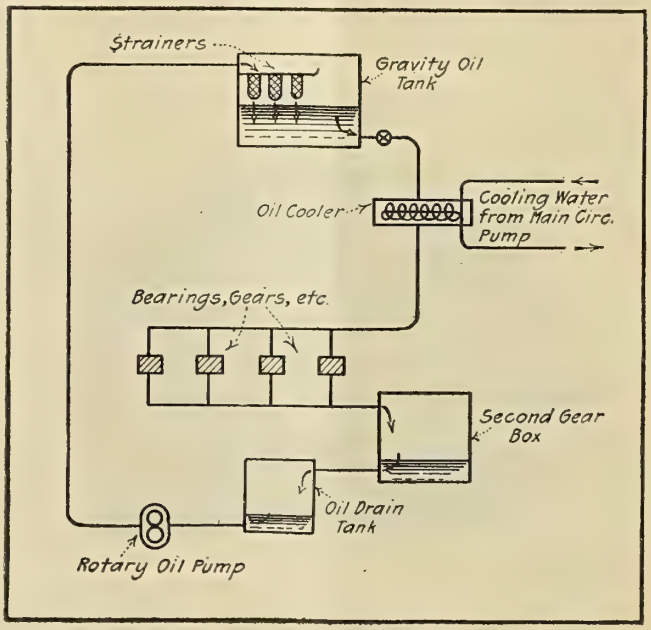


Fig. 18.—Lubricating System

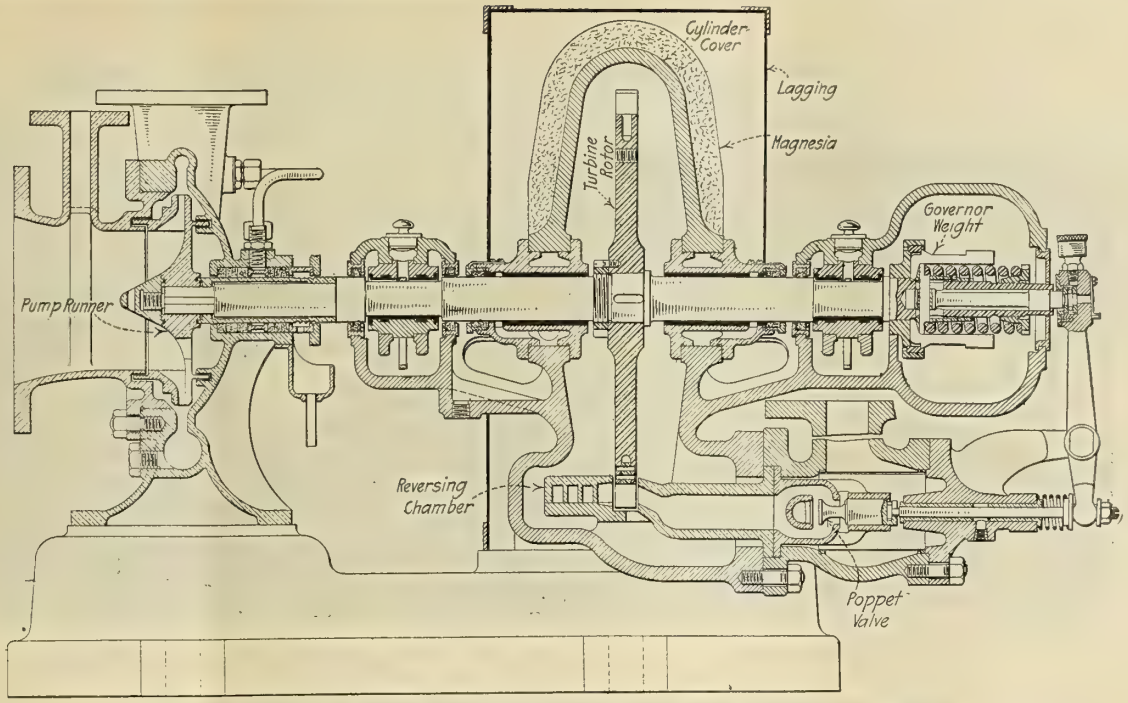


Fig. 19.—Section Through Condensate Pump Unit, showing Turbine and Pump

mum speed. They do not, however, stop the turbines, which might be troublesome, particularly in the case of the propellers racing in a heavy seaway.

The turbines have a considerable overload capacity and reversing power, the latter being 60 percent of the ahead full power with the same flow of steam, and about 80 percent when the flow of steam is increased during the short reversing period—not over two minutes usually. This reversing power is about the same as that of reciprocating engines and is quite ample for all requirements.

Many who are not familiar with geared turbines have the impression that with this type of machinery, insufficient backing power is characteristic, the same as with direct drive turbines from which the present type was evolved. This, however, is not correct. With the direct drive machinery, due to the unfavorable speed under which they operate, the efficiency of both the turbine and propeller is low, giving a very low overall efficiency. With the geared machinery, both the turbine and propeller operate at speeds which give high efficiencies for both turbine and propeller, and relatively a much higher overall efficiency, or stopping power. It is obvious that by doubling the efficiencies of both turbine and propeller, the power of the turbine is doubled, and that of the propeller —i. e., the effective stopping power—is quadrupled, which is substantially the relation between direct drive and geared turbines.

It may be added that the size and efficiency of the propellers are of more importance than high backing power. In stopping the vessel, the large propellers used with geared turbines "take hold of the water" better up to their breaking down point, beyond which additional power is of little advantage. With the maximum flow of steam, geared turbines develop about as much power as can be used effectively by the propellers.

The turbines are provided with group control of the nozzles to obtain more economical use of the steam at reduced powers. In addition to the usual steam seals for turbine glands, water seals also are provided for use while the turbines are in normal operation, since they give a perfect seal with absolutely no leakage whatever of steam into the engine room. Water seals have been extensively used on land turbines and have given most satisfactory results.*

The turbine blading is of the Westinghouse standard type and is particularly rugged and substantial. The blades are held in the rotor by mechanical locks and are amply secured against vibration.

The reduction gears are the latest Westinghouse type with mechanical floating frames to maintain the pinion alinement. The Kingsbury thrust bearing incorporated in the second gear is a considerable improvement over the usual type of thrust block. The measurement of power with the hydraulic dynamometers is a desirable feature for checking the ship's performance in service. The duplicate direct driven rotary oil pumps are very simple and reliable and are claimed by the manufacturers to be more economical than independent pumps, besides requiring less attention.

The condensing plant has many important improvements. The turbine driven rotary pumps are also claimed to be a great improvement, both mechanically and economically, over the reciprocating types. The geared turbine drive on the circulating pump permits a slow speed pump and a high speed turbine, resulting in a very economical unit. These rotary machines require a minimum of attention and repairs. The Leblanc air ejectors are a great improvement over air pumps with respect to steam consumed, weight, space, care and repairs. It is an exceedingly simple static machine which requires the minimum attention.

As far as is known, this is the first marine installation in which propelling machinery, both main and auxiliary, is entirely of the rotary type. Since the advantages of rotative machinery are considerable, it is believed that the present installation is preliminary to the more general adoption of rotative main and auxiliary machinery for marine service.

* For seventeen years all Westinghouse turbines except some small impulse turbines have been equipped with water sealed glands.

VIEWS OF SKINNER & EDDY SHIPYARD AT SEATTLE

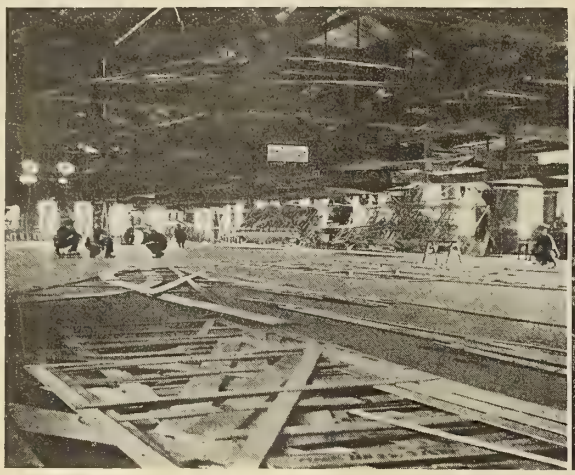


Fig. 1.—Mold Loft



Fig. 2.—Shipfitters' Layout Area and Plate Racks



Fig. 3.—Drafting Room

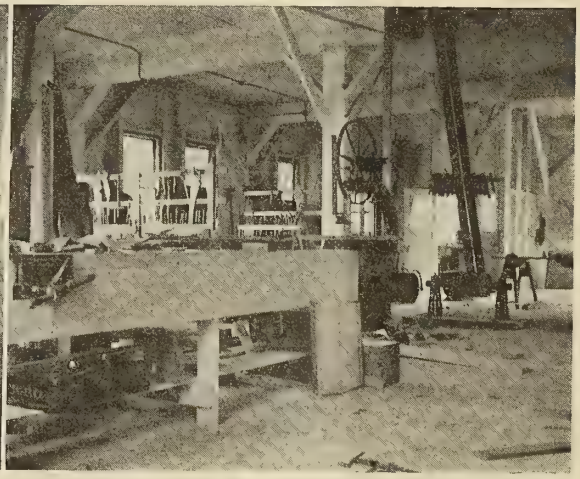


Fig. 4.—Pattern Shop

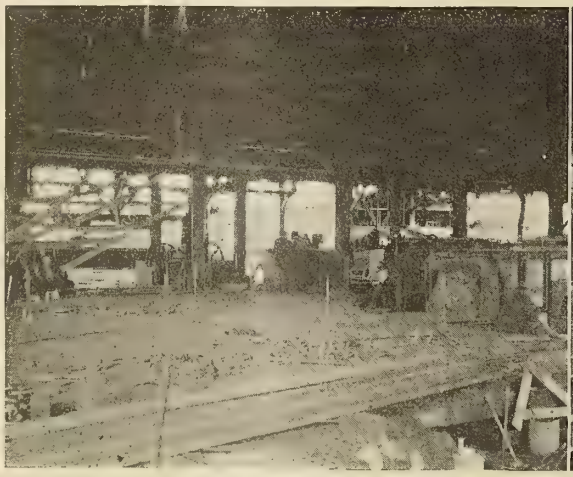


Fig. 5.—Bending Slabs and Furnaces

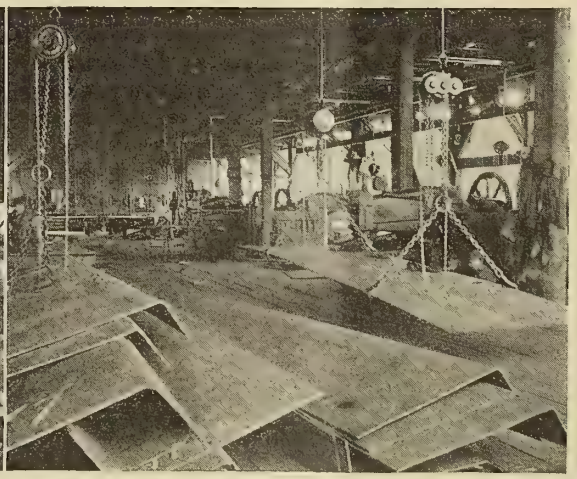


Fig. 6.—Plate and Angle Shop



Fig. 7.—General View of Skinner & Eddy Shipyard

The New Skinner & Eddy Shipyard

Steel Shipbuilding Facilities on Puget Sound Increased by New Plant Covering Twenty-Three Acres

BY GILBERT C. DOHM

WITH the revival of shipbuilding in this country, due to the present great demand for merchant ships, the Pacific Coast is doing its share toward furthering the progress of this industry. From the Canadian to the Mexican border a number of yards have been organized or are being organized to take care of the demand for new ships, or the repairing of the older ones.

Seattle has been particularly fortunate in this respect in the establishing of a new large steel shipbuilding plant by the Skinner & Eddy Corporation of that city.

On the site of the old wooden shipbuilding yard of Nelson & Kelez, and with much additional area added thereto, this yard was built up. The last ship launched by Nelson & Kelez was called the *Progress,* which name seemed to have been a forerunner of the present establishment, for immediately after this launching the building slips for the steel ships now under construction were prepared.

Covering approximately an area of 23 acres, and situated on Elliott Bay, with its deep and open fairway into Puget Sound, and adjacent to Seattle's busy waterfront and commercial center, the location of this yard is ideal for handling work of large size. Material is received over five transcontinental railroads—the Chicago, Milwaukee & St. Paul, Oregon-Washington Railroad & Navigation Company, Great Northern, Northern Pacific, and Canadian Pacific, and also over the Columbia and Puget Sound. As the yard property parallels a portion of the railroad tracks, it was only necessary to lay down a short siding to connect with the tracks already within the yard limits. Material can therefore be conveyed to any part of the plant on the railroad company's cars, or taken directly to the storage racks and transferred to these by the traveling cranes.

Preparations for the building of this plant were made last December, with the idea of having an equipment with which to turn out a number of ships for the private use of the Skinner & Eddy Corporation. This idea was soon after enlarged upon, when a sufficient number of contracts were available for the building of ships for other interests, and equipment sufficient for handling the work on four ships under construction at one time was installed.

Due to the scarcity of structural building material and the urgent need for fabricating buildings, mold loft, etc.,

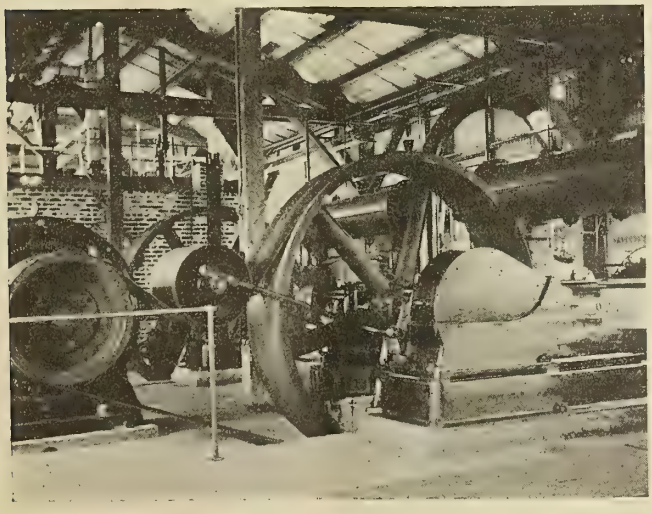


Fig. 8.—Interior of Power House

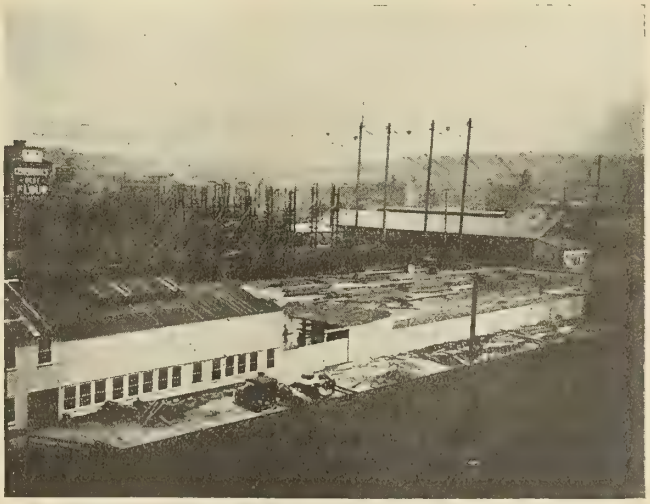


Fig. 9.—Aerial Tramway for Conveying Material

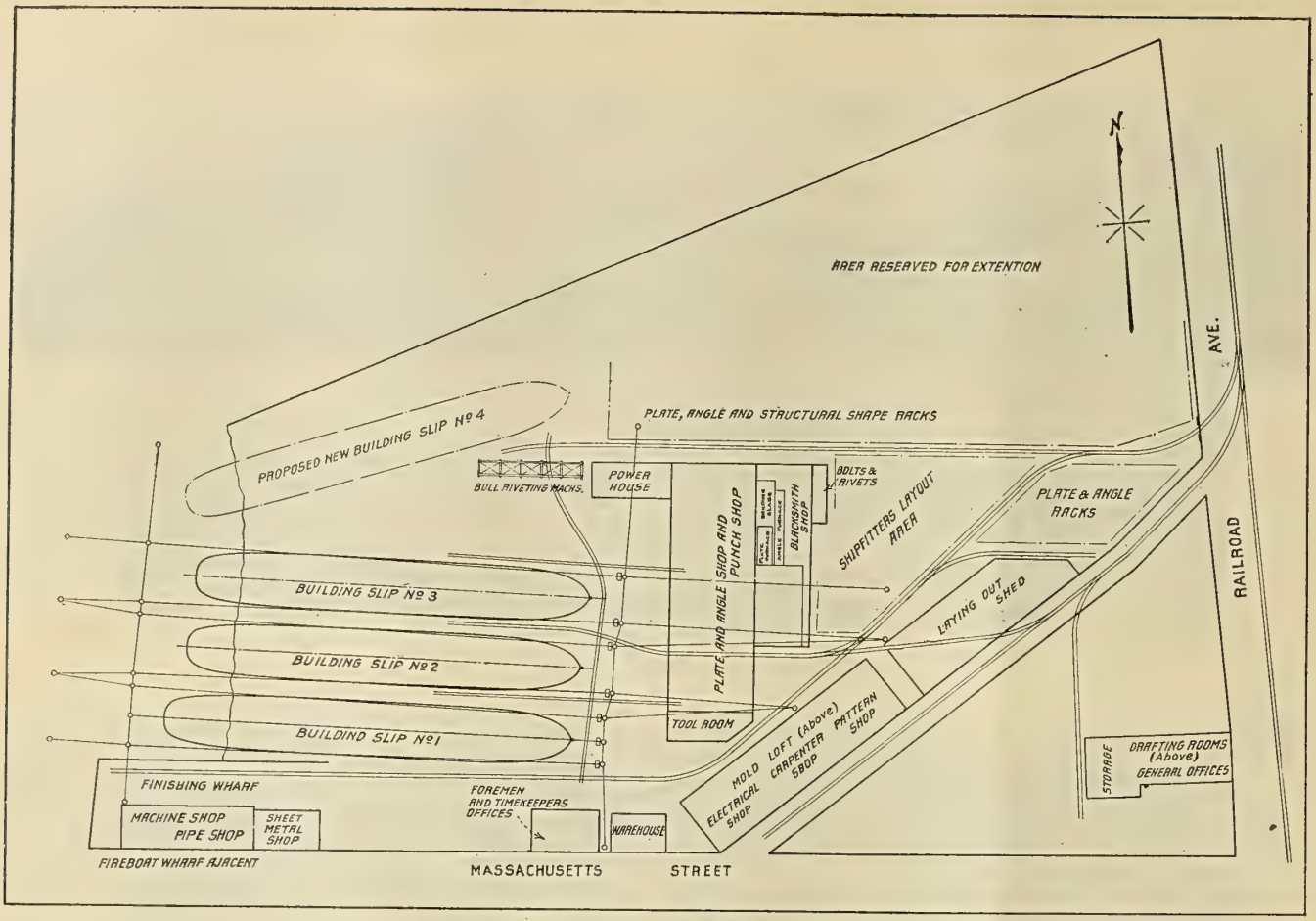


Fig. 10.—Plan of Skinner & Eddy Shipyard

it was deemed advisable to erect suitable temporary structures of heavy timber, which is available and can be had on short notice in the West. The stress members were all well braced and made of sizes sufficiently great to withstand the shocks from the overhead traveling cranes, the jib cranes which serve individual machines and the wall cranes. On account of this timber construction, very efficient methods of fire prevention and fire control were immediately installed.

The layout of the plant is as shown in Fig. 10. Much of the open space is used at present for the storage of the plates and structural shapes which the company has been successful in placing contracts for, and which material is constantly arriving. There is also a portion of the yard set aside for the storage of structures and parts built up or bent into shape beforehand, such as floors, frames, shaft alley framing, beams and brackets, etc., and awaiting to be installed on their respective ships.

The power house, which is the source of all energy for the yard, is equipped with two Chicago Pneumatic Tool Company's air compressors of 14,000 cubic feet capacity each, which supply the compressed air for the drills, riveting and reaming machines, and also five bull riveters. These compressors are driven by a Westinghouse 200 horsepower motor. Another compressor of 500 cubic feet capacity is soon to be installed. Steam for use in the blacksmith shop, plate and angle shop, yard heating system, winches, etc., is furnished by a 150 horsepower oil burning boiler. The furnaces and forges in the yard are also oil burning and fuel under pressure is received by them from an oil pump located in the power house. The steam and oil lines are all carried under ground.

The plate and angle shop is fully equipped with planers, reamers, shears, rolls, drills, punching machines, etc. A bolt and rivet making machine has also been installed.

The blacksmith shop and furnaces are also complete and up to date.

The mold loft, which was recently raised bodily 12 feet, to permit the building of a carpenter shop, joiner shop and electrical shop below, has upon its floor at present the lines of ships Nos. 3 and 4.

The machine shop, pipe shop and sheet metal shop are still under construction and will be completed by July 10.

Particular attention has been given in all cases to the ease and systematic routine of conveying the structural shapes through their various stages, from one point to another, with the least possible mechanical energy.

A unique feature is the method of conveying the structural shapes and plates to the ship. To install cranes would have necessitated the spending of considerable time which was not then available. To overcome this difficulty a system which is used to some extent abroad was installed. Upon an aerial tramway on either side of the ship, consisting of a fixed wire cable supported by two timber uprights, travel two trolleys which carry the hoisting cables and shackles. These uprights are about 16 inches in diameter at the top, and being the natural tree assume their own diameter at the bottom. They are placed at the forward and after ends of the ways, the forward upright being about 100 feet high and the after upright, which is out in the water and sheathed in copper, about 90 feet high. Both are set into the ground about 10 feet and canted away from one another at an inclination of one foot cant to 7 feet length of upright and are stayed in position by cables fastened to dolphins about

SHIPWAYS AND AERIAL TRAMWAYS



Fig. 11.—Building Ways



Fig. 12.—Looking Forward in Building Slip



Fig. 13.—Conveying Beam to Ship



Fig. 14.—Placing Beam in Position

150 feet away. The cable assumes the shape of a catenary when free of any weight and is 1¾ inches in diameter.

The hoisting cables are operated by means of two electric winches at the forward uprights, signals being given to raise or lower from any position on the ship to the operator at the winch by a bell system. As the uprights supporting the two tramways are at a greater distance apart than the breadth of the ship, the material is carried out, suspended from both trolleys, and when the proper athwartship position is reached, the hoisting cables are lowered in such a manner as to swing the structure into its proper position. Due to the declivity of the tramway no power is required to take the material out and only sufficient power is required after the material has been delivered to bring back the empty trolley.

Upon smaller wires stretched from upright to upright runs a trolley conveying the wire and electric push button for signaling, the two supporting wires serving also to carry the electric current.

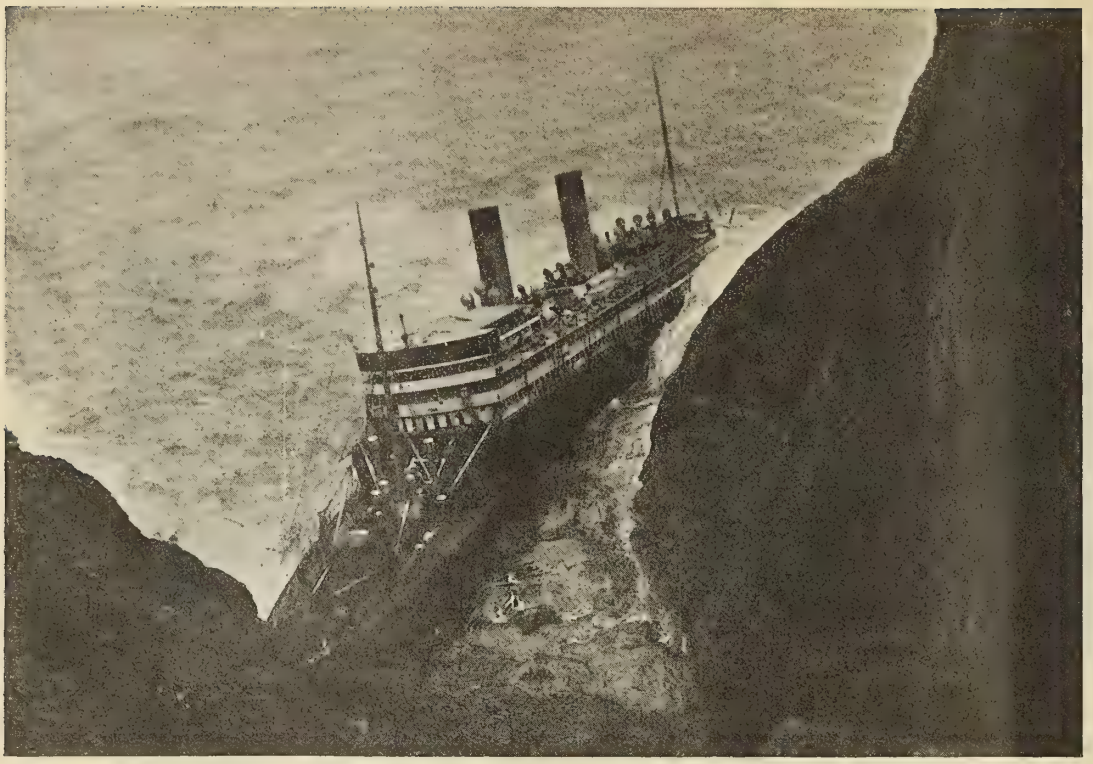
This method of conveying has been found extremely efficient and economical, and with a little practice on the part of the weight handlers is easily managed.

Two building slips are now completed, a third is under construction, and a fourth will soon be started. Work has advanced rapidly on two ships which are now about twenty-five percent to fifty percent complete, and a third will be started as soon as the keel blocks are prepared.

Immediately upon launching the ships will be taken to the finishing wharf adjacent to the machine shop and the machinery installed and final adjustments made.

Contracts for six ships are at present on hand. The yard employs about 1,900 men and is working three eight-hour shifts a day.

Diesel Engined Excursion Boat.—A new sight-seeing excursion boat, the *Palisades,* was recently placed in commission by the Palisades Interstate Park Commission, to run between New York City and the various playgrounds of Palisades Park. The vessel is of the house-boat type, 120 feet long, with a capacity for 300 passengers, and is propelled by Southwark-Harris valveless heavy oil engines, built by the Southwark Foundry & Machine Company, Philadelphia, Pa.



Photograph by International Film Service

Fig. 1.—Position of the Chiyo Maru on the Rocks Outside Hong Kong Harbor

Wreck of the Japanese Liner Chiyo Maru

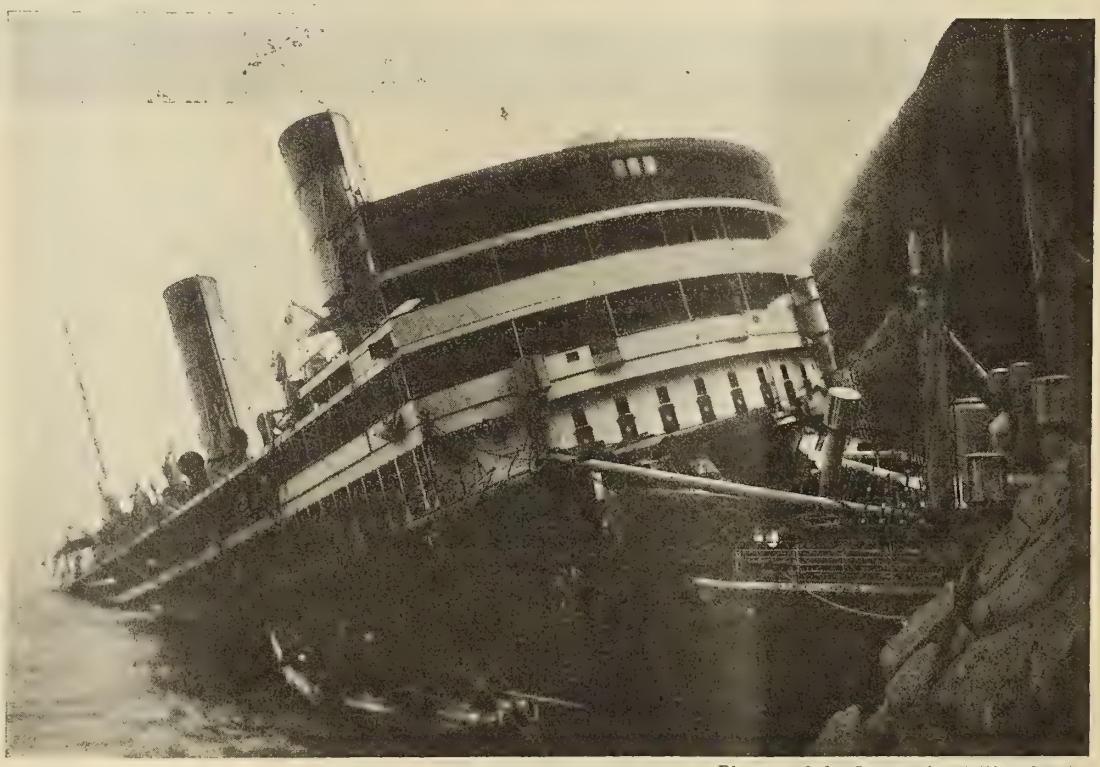
During a dense fog on the night of March 31, 1916, the Japanese liner *Chiyo Maru,* of the Toyo Kisen Kaisha Steamship Company, ran aground on Lema Island near the entrance to Hong Kong harbor. The accident occurred a little after midnight when everything was in complete darkness. The illustrations shown on this page, taken a few hours later, show plainly that the surf in washing over the vessel's stern had already broken her apart. No lives were lost, however, as, in spite of the fact that the ship had a considerable list, all of her passengers and crew were saved in lifeboats, and within a few hours were transferred to a British torpedo boat destroyer and brought to Hong Kong. The fact that all lifeboats on the vessel were successfully launched under very severe conditions without the loss of a single life testifies to the efficiency of the Welin quadrant davits with which the ship was equipped.

After salvage operations had been undertaken, the vessel became a complete wreck and has since been abandoned.

The *Chiyo Maru* was 575 feet long, 63 feet beam and 46 feet 6 inches depth, molded to shelter deck. She was of 14,000 tons gross register, 22,000 tons displacement and had a carrying capacity of 275 first class, 54 second class and 800 Asiatic steerage passengers.

The vessel was insured in the Tokyo Marine Insurance Company for 4,000,000 yen and reinsured in several London companies. After the insurance adjustments are settled the wreck will be sold at auction and the iron, steel, brass and other metals used in the construction of the vessel will have considerable value in the present market.

Trial Trip of the Tioga.—On the trial trip of the new harbor cutter *Tioga,* recently launched at Solomon's Island, Maryland, the vessel developed a speed of 9.6 knots.



Photograph by International Film Service

Fig. 2.—Break in the Hull Forward of the Superstructure

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Refitting Main Bearings

Recently, after completing a 12,000-mile cruise, it was found necessary to refit several of our main bearings, both top and bottom. The top cap is of steel with babbit lining and the lower half of composition. On removal it

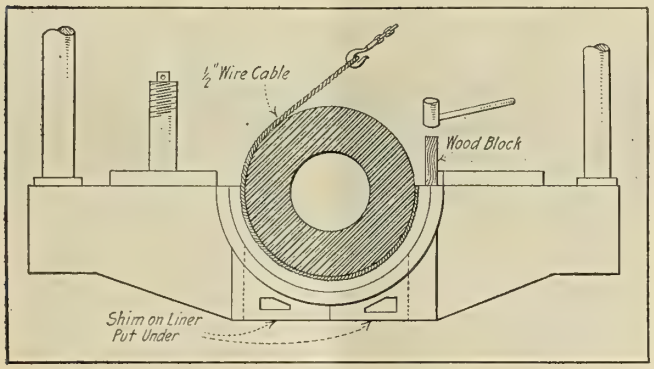


Fig. 1

was found that the top caps had run or wiped the white metal, so that the oil grooves were filled in the lower half, necessitating their removal.

As work was being done in the cylinders and other parts of the engine, the lower brasses could not be turned out with the jacking engine, so a chain fall and piece of wire cable were used, as shown in Fig. 1. This method proved to be much better, as well as quicker, allowing the weight of the crankshaft to be taken up by blocking and wedges. A strain was taken on the cable, assisted by a heavy maul and wood block, as shown in Fig. 1. To be more effective, the chain fall should be shifted to various positions.

Fig. 2 shows the oil grooves in the lower brass. The plain circular grooves were all that were in the brass. On removal the four wing grooves, as shown by dotted lines, were added. This provides a small reservoir to accumulate oil when the engine is stopped with the oil wicks in.

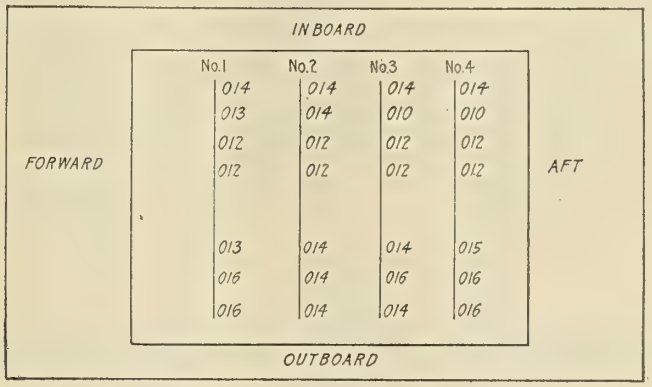


Fig. 3

The lower brass was spotted into the shaft and scraped, then replaced and feelers used to see that the shaft bedded in it. It was found that a two-thousandths shim was needed to raise it. It was again rolled out and a shim put under the shoe in which the brass sets, and again replaced.

The top caps were refitted by taking leads. When the set of leads is taken out of the cap they are measured and their thicknesses are written on a sheet of paper, as shown in Fig. 3. This shows at a glance the way in which the bearing cap sets and shows the "high spots." With this paper in front of you, when you are scraping the cap, you are prevented from scraping the wrong part of your bearing.

C. H. W.

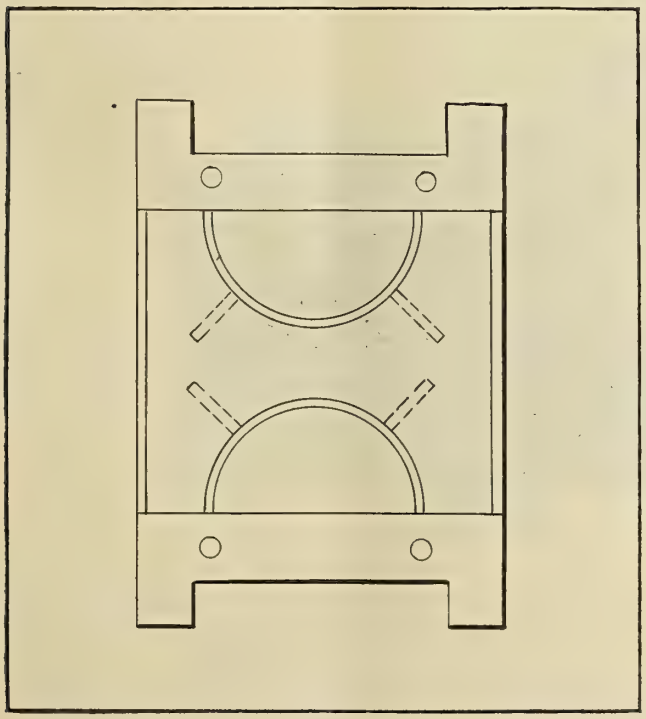


Fig. 2

Indexing and Filing Engineering Data

Following the suggestion made in one of the editorials in the April issue, I am enclosing a few samples of my index cards to show the method I use in filing and classifying data on engineering subjects.

SHIP, Unsinkable,

A very interesting communication on the possibility of building a large passenger liner that would not under any of the known mishaps at sea lose her buoyancy, or stability and sink.

By George W. Dickie.

Sc. American, Vol CX, pp. 86 & 91.

1913 Proceedings of the S.N.A.& M.E.,--.25-29

Int.Mar.Eng.,Vol. XIX, pp. 60-62.

Fig. 1.—Index Card

MERCHANT VESSELS, Notes on the performance of the S. S. "TYLER".
A plea for adequate trial trips of merchant vessels- Trial data from an interesting cargo steamship built for the Old Dominion Line.
By E. H. Rigg.
Int.Mer.Eng. Vol. XIX, pp. 29-31.

Fig. 2.—Index Card

My course of action in this regard is as follows: In looking over the pages of a technical publication, book or magazine, I carefully read over any article bearing on my daily work or any article which seems of value from the standpoint of general knowledge. Then an index card is filled out with the title of the article and the name of its author, followed by a comment or note regarding the nature of the article, and finally by a note stating where the article can be found.

AUG. SUZARA,
Steamboat Inspector.

Cebu, P. I.

Deterioration of Tail Shafts in Tropical Waters

The illustrations show three views of sections of the port tail shaft of the steamer *Marinduque*, a twin screw survey steamer of 411 gross tons, used by the United States Coast and Geodetic Survey in the Sulu Sea along the coast of Palawan Island, P. I. The tail shaft is 6 7/16 inches diameter and 9 feet 2 inches long between the stern bearing and strut bearing. Composition sleeves are fitted on the shaft at the bearings and the hull is of composite build sheathed with yellow metal and fitted with composition propellers. The temperature of the sea water is about 86 degrees Fahrenheit.

The shaft shown in the illustrations was installed new and painted with three applications of black asphaltum, well dried between each coat before the shaft was installed. The shaft was not served with marline or other protection, as the steamer was needed at once to go to the aid of a survey party on Dumaran Island.

At the end of six months the steamer was hauled out on a marine railway and the deterioration was found to be so great that the shaft was condemned. In the illustrations, where the shaft appears smooth, the asphaltum is as good as when applied, but where the shaft was attacked, it is in a condition resembling decayed wood.

This is the third port tail shaft on this vessel which



Fig. 2.—Port Tail Shaft, showing the Brass Sleeve which Rests in Stern Bearing. Deterioration More Pronounced Next to Stern Bearing and Hull



Fig. 3.—Yellow Metal Sheathing Composition Sleeve on Shaft in Stern and Strut Bearings



Fig. 1.—U. S. S. *Marinduque* Coaling at Puerto Princesa, Palawan, P. I.



Fig. 4.—Tail Shaft, Yellow Metal Sheathing Composition Sleeves on Shaft. Composition Propeller. Temperature of Sea Water 86 Degrees F. Time in Water, Six Months

has deteriorated in this manner. The shafts are 8 feet apart and turn inboard. Between the two main thrust bearings is a 10-kilowatt dynamo. The steamer *Marinduque* was built in Uraga, Japan, in 1902.

C. M. Conover.

Puerta Princesa, Palawan, P. I.

Leaky Boiler Tubes

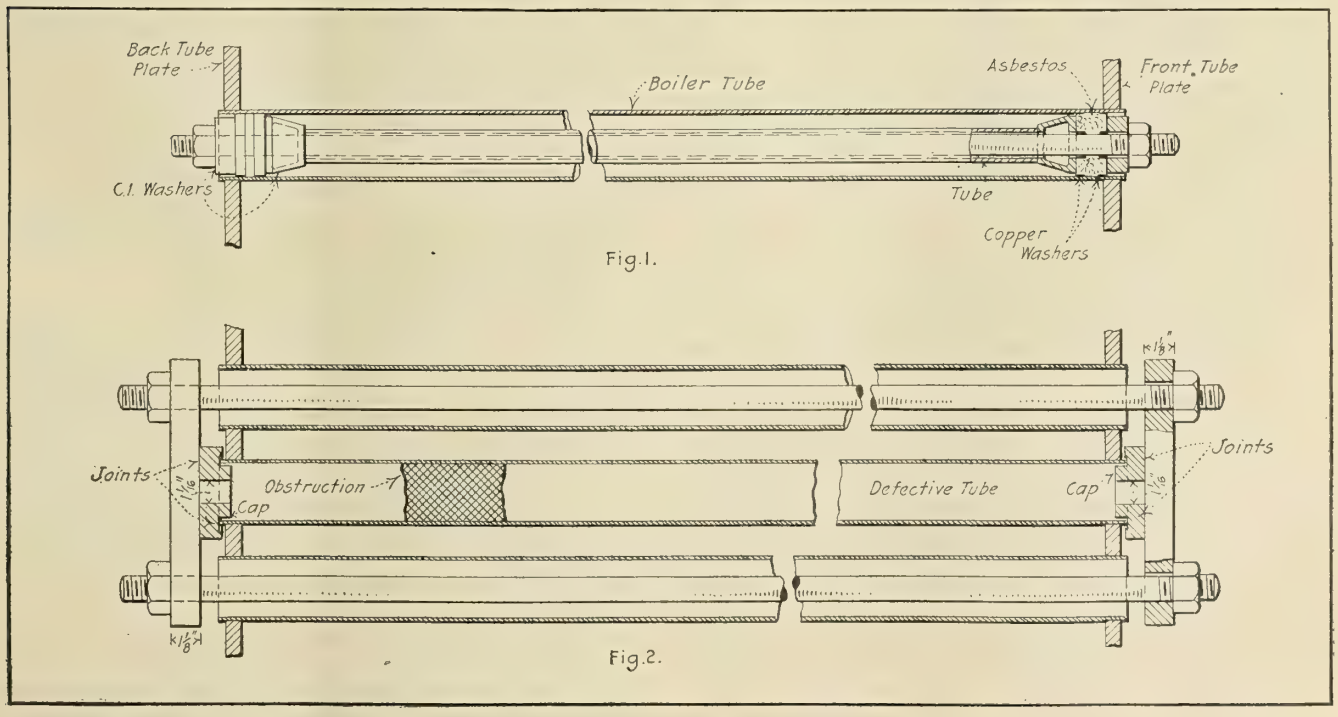
The boilers in a passenger ship I sailed in were of the marine multitubular, wet bottom type, better known as the Scotch boiler. Two of them were double-ended and two single-ended. Their condition was very bad, especially the tubes, which were constantly giving out. When we observed signs of a leaky tube—water coming from the ashpit or smoke casing door—we opened the latter, and, if at all possible, fitted a tube stopper, as shown in Fig. 1.

These we found very serviceable if the leak was not too great to permit of them being fitted. We always tried this method first, as it did not necessitate the shutting and blowing down of the boiler to get into the combustion chamber, thereby saving much time and delay—an important factor to a passenger ship. This reasoning applied more to the double-enders, which, if put out of action, meant a great reduction in speed for a considerable time.

The particular case which I wish to speak of was the worst we had, and happened when homeward bound, some five or six days from port. The first indication we had was water coming from center smoke casing door of one of the donble-ended boilers. The forced draft was shut off to the center furnace, the fire allowed to die down, then drawn, particular care being taken to regulate the feed. The ashpit and casing doors were than opened by means of a rake, everybody standing clear. We always took this precaution, because, with a closed ashpit, one never knew how much scalding water might have collected there. I remember in the same ship a fireman got badly scalded about the feet through deliberately unheeding the warning to stand clear.

To continue, we lifted the casing door up horizontally and located the leaky tube. A patent tube stopper was tried in, but it would only go a certain distance and no further. This seemed strange, so, withdrawing it, we tried a long stay, but with the same result. There was soot, and probably salt, in a solid mass choking the tube. We observed that in this case no water was coming from the back end through the ashpit, so we concluded that the leaky part of the tube was between the obstruction and the front tube plate. As to the distance that existed between the break and the obstruction, we could not possibly find out; however, we determined to fit a stopper, so cutting the stay and its tube to the required length and screwing the former, we inserted it, tightened up the nuts, and were successful in stopping the leak.

Two or three days afterwards we were much annoyed to see water coming from the same door, and when it was ascertained to be the same tube we vented our feelings in the profane manner peculiar to marine engineers. We tightened up the nut, but as that failed to stop the leak, the chief decided to draw all six fires, shut and blow down the boiler, and when cool enough, examine the faulty tube from the back end. From there it was found that a short chisel bar would only go about 14 inches into the tube. All means were tried from both ends to remove the obstruction, but with no success; even a slice per-



Construction and Arrangement of Tube Stoppers

suaded by a "Monday" hammer failed to make a passage. Our idea, had we succeeded, was to fit an ordinary tube stopper. (Fig. 2 shows the details of such a stopper, only the caps and stays are in different tubes.)

The tube had to be blanked off somehow, so in preference to cutting it out, we made the following repair quickly and in such a manner that we had no further trouble.

Two stays, 1 inch diameter, were put through the neighboring tubes, as shown in Fig. 2. Joints of well-made red lead putty and gauze wire were inserted between the ends of the tube and caps. Two plates, 1⅛ inches thick, were in the meantime being prepared to fit over the ends of two stays, and of sufficient breadth to cover the cap. Two other joints of same material were put between the caps and plates.

When everything was ready the nuts were screwed up, care being taken to put an equal strain on both stays, so as to prevent the plates canting.

The boiler was filled up, and when water was past the tube level all was tight. When steam was raised a little more tension was put on the stays from the front end. As aforesaid, we had no further trouble with this tube.

When we reached port a good many of the tubes were renewed, to the great satisfaction of the ship's engineers.

"VAKITID."

Analyzing a Marine Steam Plant*

A good boiler will, under favorable conditions, absorb 80 to 85 percent of the heat given off by the fuel; but more usual results range from 60 to 70 percent, and some boilers of poor design, in poor condition, will run as low as 50 percent, particularly if crowded. To be efficient a boiler must have plenty of heating surface as compared to the grate surface and must not be crowded in respect to the load it carries. Practical conditions demand a compromise between efficiency and capacity. Also it must be remembered that it is not pounds of coal per horsepower that the owners care about, but the pounds of coal per mile traveled with passenger ships and pounds of coal per ton of freight per mile with cargo boats. The coal used per ton of freight is much more important than the coal per horsepower, and some boats make a better showing per ton mile when their steam plant shows a larger amount of coal per indicated horsepower. All steamship economics, whether expense or revenue, should be figured out on a basis of a ton mile, rather than per horsepower, because this gives a basis by which expenses and supplies can be compared with revenue.

The efficiency of the boiler depends upon the soot in the tubes and the scale within the boiler, among other things. The proper care of soot and scale is so well known to the practical engineer that nothing need be said, except to emphasize the importance of anything that will help these conditions, as they greatly affect the economy of the boiler.

Many more boilers are improperly designed than generally supposed. They are strong enough, for the government sees to that; but the proportions are often not what they should be. The boiler has been built cheaply, and is small for the work expected or does not make proper allowance for reductions in pressure required by the government, or the smokestack is small, or large, or not high enough, or the tubes are not proportioned in area to the furnace, or are too short to bring the gases down to a proper stack temperature.

* For previous letters on this subject see April, May and June issues.

The following are some of the proportions adopted in boilers which gave results as noted. These boilers and tests have been selected from widely different sources, but all of the tests were conducted with coal of approximately the same analysis and the tests were made under fairly similar conditions.

Name of Boiler.	Watertube Type.	Scotch Type.
Economy tests:		
Heating surface	35 to 40 ratio	24 to 30
Grate surface	35 to 40 ratio	24 to 30
Coal burned per square foot grate surface per hour	8 to 12 pounds	20 to 24 pounds
Percent ash	9 to 12	9 to 12
Water evaporated from 100 degrees F. to 70 pounds	About 2.75 pounds	.....
Water evaoprated from and at 212 degrees F	About 11 pounds.	About 9.9 pounds
Stack temperature	400 to 600 degs. F.	700 to 900 degs. F.
Boiler horsepower	About 85.	.....
Capacity Tests:		
Water evaporated from and at 212 degrees F	9 to 11 pounds	9 pounds.
Boiler horsepower	About 110.	.....
Coal burned per square foot of grate surface	.....	38 pounds.

In comparing boilers the most important characteristic is the ratio between the heating surface and the grate surface. In highly economical boilers this figure rises to forty—that is, the heating surface is forty times the grate surface. Some boilers on land, notably the German Fermenich, have as high as 64, but 40 is the average for a watertube marine boiler, while Scotch boilers vary from 25 to 35. On the other hand, the Scotch boiler must burn more coal per square foot of grate surface in order to compensate for its deficiency in heating surface.

The Scotch boiler weighs more and takes more space than any other type of steam boiler in use to-day for the same power and steam pressure, with the single exception of the locomotive type, which is the heaviest of all. The arguments for the Scotch boiler are its relatively low cost, its ease of access and upkeep, its ability to steam for long periods without attention and its capacity for absorbing variations of steam consumption and firing, because of the immense body of water which it holds.

A watertube boiler, whatever its advantages, is a constant worry to a water tender, because of the quickness with which it "loses its water," and feed lines cannot be kept going absolutely without stoppage, and while an auxiliary feed line may be in perfect condition theoretically, it is often found at the critical moment with frozen valves, missing valve wheels, or plugged with dirt, or with a leaky, dried-out gasket in some joint, or the auxiliary feed pump has been used as a fire pump and is full of mud, etc. All of these elements must be considered in those larger economies which are realized from well kept schedules and reliable trips.

A Scotch boiler evaporates about ½ pound of water for each cubic foot of space occupied, and weighs about 2.3 pounds for each pound of water evaporated. A watertube boiler evaporates 1 pound to 1¼ pounds for each cubic foot of space occupied, and weighs 1 pound to 1½ pounds for each pound of water evaporated.

As this series of letters is intended to deal primarily with the analysis of existing plants, the foregoing explanations are made only that readers may "size up" an existing plant in which they may be interested, with a view to placing it with regard to what the plant *ought* to accomplish.

An engineer is always faced with two aspects of economy which are more or less opposed; he wants to operate as economically as possible, but a far more important feature is to be able to make his trips reliably and maintain his schedules to the last word. Repairs and improve-

ments must be so carefully planned that the earning power of the boat is not interfered with. When a boat is laid up, or coaling, or in drydock, it is not earning a revenue for the owners and the boat's ability to earn revenue is its only right to existence. When it cannot do that, it must be scrapped. It is well to keep the expenses down, but it is far more important to keep the earnings up. This side of the question must be considered in connection with the boilers more than any other part of the ship, as it is entirely a matter of judgment when they should be cleaned, repaired, etc. In the same manner must an engineer decide about the use of boiler compounds, zinc plates, feed water filters, purifiers, bottom blow, surface blow, and the extent to which the boiler is crowded. The deciding question in connection with each of these devices is, do they increase the earning power of the ship?

The writer has in mind a coastwise steamer which installed evaporators. They saved a small amount in fresh water bills, but took the services of a good man and helper for one day each trip to clean. The superintending engineer transferred them to a transpacific steamer and spent the money realized on devices for cooling off the fireroom, which resulted in such increased efficiency of the firemen that the earning power of the ship was perceptibly increased and the water necessary for the short coastwise trips was purchased outright.

Another chief found a boiler compound which removed practically all of the boiler scale, but it corroded the boiler and went over into the engine, coated all of the working surfaces and interfered with the lubrication, and the boat missed a trip while the engines were cleaned out and the corroded boilers thoroughly inspected.

The two important points of the operation of a steam boiler, relative to economy, are the condition of the surfaces of the metal transmitting the heat and the difference of temperature. If the surfaces are coated with soot on the outside and scale on the inside, the efficiency may be very low indeed. The temperature of ingoing feed water is something more than 120 degrees F. The boilers' temperatures run from 300 to 500 degrees where a superheater is used. The furnace temperature ranges from 3,000 degrees Fahr. to 1,000 or less in the stack. The difference between the temperatures of the furnace and boiler is a measure of the rate of flow from the furnace to the boiler. If the furnace temperature is very high, more heat will go to the boiler, but more will also go up the stack. If the fire is not crowded, the boiler gets more of the heat because the stack temperatures are not so high. It is doubtful if superheaters increase the earning power of a ship unless on very long voyages, when consideration is given to their upkeep and the difficulty of lubricating the high pressure cylinders and valves and the ever-present trouble with rings, especially where the high pressure cylinder is jacketed, as on the U. S. S. *Tacoma*.

Another phase of economy is the preserving of the life of a boiler. The policy governing this falls on the superintending engineer more than the ship's chief because, owing to the unfortunate condition of our merchant marine, the average chief does not look upon his position as sufficiently permanent to take a deep and abiding interest in the permanent preservation of his plant. Such care as this would include protecting the boiler from sudden changes of temperature, such as opening the connection doors or the furnace doors except when necessary, the careful use of boiler compounds and zinc plates, corrosion from various causes chemical and physical in character, and cleaning of the interior.

After the heat has once been transmitted to the water and steam, the problem becomes one of preventing its loss through radiation. The water and steam are only vehicles for the heat and the economy of the steam engine is limited by the physical properties of water and steam. Gas engines use the products of combustion as the vehicle of heat and are limited by their physical peculiarities. Refrigerating machines use ammonia, or ether, or carbon dioxide, or sulphur dioxide, or air, because each of these vehicles has properties which make refrigeration possible. When a pound of water is raised from about 120 degrees to the temperature corresponding to 165 pounds pressure, about 250 B. T. U. are required; then when the water is converted into steam, 850 B. T. U. in addition are required. Therefore, any condensation represents losses at the rate of 850 B. T. U. for each pound of steam condensed. The steam, as it arrives at the engine, contains from 2 to 10 percent of moisture. Take, for example, a 1,000 horsepower engine using 12 pounds of steam per hour per horsepower (an average condition), making a total of 12,000 pounds of water per hour. Five percent of moisture would be 600 pounds. At 850 B. T. U. this would be 510,000 B. T. U. Assuming that the coal runs an average of 8,000 B. T. U. per pound and the efficiency of the boiler is an average of 65 percent, there is a net 5,200 B. T. U. delivered to the water for each pound of coal, therefore 510,000 divided by 5,200 gives about 980 pounds of coal going to waste per hour because of the moisture in the steam. A good steam separator will remove the most of the moisture; but this is not economy, because it does not restore the heat which has been lost by the condensation of the steam.

The only true economy is to prevent, so far as possible, this loss of heat by lagging the boiler and steam pipes with the best lagging that can be procured. The lagging must be of such quality and quantity that the outside of the covering feels only slightly warm to the hand. Money is well spent on good lagging, as it is one of the truest and most profitable of economies.

The greatest value of superheated steam is that it practically eliminates the moisture. Saturated steam is at the same temperature as the water from which it came, but superheated steam is hotter than the water from which it came at that particular pressure and can, therefore, cool down a little before it condenses. Saturated steam, on the other hand, condenses with the slightest cooling down. This elimination of moisture does not represent a real saving, though, because the heat is radiated slightly faster because of the higher temperature of superheated steam. Superheaters usually use waste heat from the stack, which represents a clear gain thermally, but they often cause practical troubles, as already noted.

All liquids have different boiling points at different pressures. They also have different pressures for various boiling points. For water at 212 degrees Fahr., the vapor pressure is 14.7 pounds per square inch (one atmosphere). For pressures less than this, the temperatures, etc., are as shown in the table on page 388.

All of these data, as well as that for latent heat, may be secured from the steam tables which are in all technical engineer's pocket books, such as Seaton's, Kent's, etc.

Since liquids have boiling points which vary with coinciding pressures, it follows that if the steam is not superheated, it is at the temperature due to the coinciding pressure. Conversely, if the pressure drops, the steam is left at the original temperature, which renders it superheated relative to the water, because it is at a higher temperature than the water. Dropping of the pressure and expansion are the same thing. If the expansion takes place while the steam is doing work, as in an engine cylinder, the temperature drops with the pressure, in accordance with the steam tables, but if the expansion is made

Inches of Mercury.	Pressure in Pounds Per Square Inch Above Zero.	Temperature—Degrees Fahrenheit.
29.74	.089	32
29.67	.122	40
29.56	.176	50
29.40	.254	60
29.19	.359	70
28.90	.502	80
28.51	.692	90
28.00	.943	100
27.88	1	102.1
25.85	2	126.3
23.83	3	141.6
21.78	4	153.1
19.74	5	162.3
17.70	6	170.1
15.67	7	176.9
13.63	8	182.9
11.60	9	188.3
9.56	10	193.2
7.52	11	197.8
5.49	12	202.0
3.45	13	205.9
1.41	14	209.6
0.00	15	212.
Gage Pressure in Pounds	And for Pressures Above Atmosphere	
100.3	115	337.8
200.3	215	393.6
335.3	350	432

without the steam doing work, as in the receiver of an engine where the steam drops in pressure from the exhaust of the preceding cylinder, or through a reducing valve on the boiler, or through a half-closed throttle, the reduction in pressure leaves the steam at its original temperature, above the temperature due to the pressure, as given in the steam tables, and the steam is superheated. It has not been heated up, the pressure has simply dropped away from it. Not only is the steam left in a superheated state, but all of the moisture is immediately evaporated because of the reduced pressure. This is why an engine will stop knocking from water in the steam if the throttle be partially closed.

One of the least known and most prolific causes of a boiler priming is the improper placing of the feed water inlet to the boiler. For the water to be converted to steam requires a certain element of time. If the inlet be so placed that the water follows a normal route of circulation before coming to the surface, it will give no trouble; but if the inlet be placed at a point where normal circulation terminates and the water is converted to steam, much cold water will be carried away with the steam, giving the impression that the boilers are priming. In a Scotch boiler the water usually sinks on the sides and rises in the center. The writer has seen feed valves connected between the furnaces, and even over the furnaces, and in each case the boiler "primed" badly.

The next letter will take up the subject of the engine, treating it analytically from the standpoint maintained throughout this serial, of analyzing existing plants, with a view to increasing the earning power of the ship, rather than any attempt to write a text-book on marine engineering. After a consideration of the power plant in each of its departments and their economic relation to the whole, it is our hope (with the permission of the editor) to write a chapter or two upon auxiliary machinery and its relation to the earning power of a ship, cargo machinery, floating repair shops, and the construction of docks, from the standpoint of the efficiency and earning power of a steamship line.

E. N. Percy.

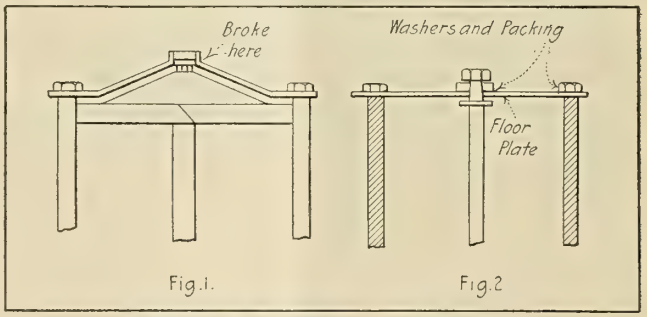
Losses to Merchant Shipping.—According to data compiled by the *Journal of Commerce*, the total losses to merchant shipping, arising from the war up to June 1 have been about 1,272 vessels of more than 2,585,362 gross tons. Approximately 57 merchant vessels of all types, having an aggregate gross tonnage of about 116,724, were destroyed during the month of May.

Emergency Repair to Circulating Engine

During a trip in some heavy weather the nut on the top of the high pressure piston rod broke loose and backed off, due to the fact that there was no cotter pin through it. The nut backed off enough to punch a hole through the cast iron cylinder head, putting the engine out of commission. As there are usually no other means aboard most ships to circulate water through the condensers, except by the main circulating pumps, the temporary repair that we devised may be a handy piece of information for some other fellow in a similar fix.

This accident happened when we had some 1,400 miles to go. The weather was bad for two days and the barometer was still going down, so I considered that a temporary repair was urgent in order to keep the engines running at slow speed.

The cylinder head was cone shaped, as shown in Fig. 1, and the clearances between it and the piston small. When



Sketch of Repairs to Cylinder Head

the nut backed off, it punched the top out, as shown by the arrow in Fig. 1.

The broken head was taken off, and the piston removed from the rod. The crank brass of this engine was taken off and the piston rod, connecting rod and crosshead were then blocked up hard and secure. Then a piece of floor plate of ribbed steel 9/16 inch thick was cut with an air hammer to a rough circle of the diameter of the head, and stud holes drilled, and also a hole in the center to fit over the piston rod, as shown. Gaskets were made and grummets of asbestos packing were put around the studs and piston rod, and with washers on top of the grummets these were all set up tight. As the steam was turned in slowly, each nut was set up again and the engine was jacked so that the low pressure was just over the center.

After looking things over, steam was admitted to the engine and she started off very nicely, running satisfactorily until we were able to repair the broken head sufficiently to enable it being replaced. This was accomplished by forming a patch in the forge to fit over the break and securing this patch on the cylinder head with screws and iron cement. C. H. W.

Sale of Chilean Ships to be Prohibited.—Dispatches from Valparaiso indicate that the Chilean Congress, recently assembled, will pass an act prohibiting the sale of Chilean merchant ships to foreigners without the consent of the Chilean government. During the past sixteen months similar legislation has been enacted in the following countries: Great Britain, Belgium, Italy, Austria-Hungary, Denmark, Germany, Russia, France, Greece, Norway, Brazil, Spain, Holland and Sweden.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Size of Equalizer Leads

Q.—Our present plant consists of a 10-kilowatt. 125-volt compound generator. A second unit, the exact duplicate of this is to be installed to operate in parallel with the first. Can you tell me how large an equalizer bus I should use? E. E.

A.—The equalizer leads may well be of the same size as the main generator leads. Practice varies somewhat in this matter, the range of size being from 0.5 to 1.0 times the sectional area of the leads to the generator.

Size of Propeller for Motor Boat

Q.—Will you please tell me what size propeller I should use for a motor boat of the following dimensions: Length on waterline, 34 feet 4 inches; breadth, 6 feet; displacement, 5,200 pounds; engine, six-cylinder, 6¼-inch by 6½-inch Niagara, 100 brake horsepower at 950 revolutions per minute. The hull is of the speed boat type and I hope to get 20 miles per hour out of her. M. B.

A.—For the horsepower given the speed is a reasonable one and a proper propeller would be 24 inches diameter by 26 inches pitch, three blades.

Direct and Indirect Valves

Q.—Isn't the use of the terms "direct" and "indirect" a recent innovation in describing engine valves? I do not remember having heard of it when I studied valves in school. Will you please tell me what they mean?

A.—A valve in which the admission of steam is controlled by the outside lap is called "direct," one taking steam on the inside is called "indirect." These terms have been in use for some time, though many of the earlier books on valve gears do not mention them.

Variation of Turning Moment in Propeller Shaft

Q.—Can you tell me, in the case of a reciprocating engine, where it is well known that the turning moment acting on the propeller shaft is not uniform, if the amount of the variation is well known and what it would be for a compound engine of about 800 indicated horsepower which runs at 78 revolutions per minute? I can figure the mean turning moment due to the indicated horsepower, but what I want is, what force to use in the calculation for line shafting, etc.? S. H. P.

A.—About 40 percent for a compound engine with the cranks at 90 degrees is a reasonable figure and somewhat less, say 35 percent for a triple with cranks at 120 degrees. These figures are fairly well determined and are in common use for design. The figures quoted are the excess of the *maximum* over the *mean* torque or rotative effect.

Classification of Terry Turbine

Q.—In what classification of turbines would you place the Terry, and would its velocity diagram be similar to any of the other commonly known makes? T. T.

A.—The Terry turbine is an impulse turbine of the so-called velocity compounded type, that is, a high initial velocity is given to the steam by one expansion or pressure drop and this velocity is partially abstracted in the adjacent moving vanes with additional velocity abstractions by passing through additional moving vanes or as in the case of the Terry a repeated passing through the same vanes. The velocity diagram simulates very closely that of the Curtis, velocity compounded, single pressure stage, turbine.

Insulating Materials for Cold Storage Compartments

Q.—We are planning to insulate a small compartment for the carriage of cold-storage products, and I wondered if you could tell me whether there have been engineering tests to determine the best substances for thermal insulation. What do you consider as the best taking account of the severe wear and tear that is inevitable in an installation of this sort? I should greatly appreciate any help that you could give me in making a decision. R. E.

A.—Of the commercially available products for insulation of refrigerated spaces cork and balsa wood rank highest from the thermal point of view, and these have been selected from the others by extensive tests reported from time to time in the engineering journals. Cork is used both in the ground form and in blocks and the balsa wood usually in boards or blocks.

Increasing Voltage of Generator Set

Q.—We have a 10 kilowatt generator direct-connected to a small two-cylinder steam engine which operates at constant speed. When the set is running under full load the lights which are at the ends of long leads are dim. I attribute this to a reduction in voltage. Will you kindly tell me if this is so, and if so what I can do to raise it, and will there be any likelihood of getting into other trouble by raising the voltage? V. T.

A.—The trouble is due to a reduction in voltage in the long leads, which may be remedied as follows with no danger of other trouble arising as a consequence of the changes:

(a) If your generator is compound wound and at present equipped with a series shunt, the addition of resistance to this series shunt will increase the voltage of the generator under load.

(b) A similar result can be obtained by adjusting the governor of the engine to give a slightly higher speed.

(c) If it is a shunt generator a few turns of series winding per pole will probably help boost the voltage, but this may be difficult to do if limited facilities only are available.

Trouble with Feed Pump

Q.—Can you suggest anything that would be likely to make a feed pump, which had worked satisfactorily for years, suddenly start jumping and persist in this despite all coaxing and care. The pump is a vertical, simplex, Worthington, used for boiler feed and discharging at about 190 pounds. It is eight years old, is in good mechanical adjustment and operates well except for this recent and persistent jumping forward on the discharge stroke. Do you know of any good book which describes the common commercial pumps from the operator's point of view? P. M.

A.—There are many possible explanations; one that suggests itself is that the erratic action may be due to air leaking in during the suction stroke which is compressed during the first part of the discharge stroke. Air may leak in through the stuffing-box, blow-holes in castings, gaskets, drains, etc. If the pump will not take a suction when starting, the valves may have been leaking from the feed line and the pump may be vapor bound, in which case turn a hose on it to cool it off. Descriptive booklets issued by the makers probably give the most reliable descriptions and the makers are glad to send them free on request. For a splendid description of com-

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mon operating troubles and their remedies see an article that appeared in the *Journal of the American Society of Naval Engineers*, November, 1915, entitled "Notes on Pumps," by S. M. Robinson, which will probably give you the information desired.

Ratio of Turbine Reduction Gearing

Q.—What is the ratio of the main turbine shaft to the driven shaft revolutions in a De Laval single-stage turbine-driven electric generating unit? The name plate gives the revolutions per minute of the electric generator as 2,000. T. E. G.

A.—Probably 10 to 1, as this a common ratio for De Laval units of small size.

Ljungstrom Turbine

Q.—Will you please tell me whether the Ljungstrom turbine is of the impulse or reaction type? I have been unable to find a definite statement concerning this point and would greatly appreciate an answer. Turbine.

A.—The Ljungstrom turbine is a radial flow turbine and embodies both principles, impulse and reaction, as there is a drop in pressure accompanied by an increase of velocity through each successive set of vanes, and the velocity so generated is used in the following set as an impulse. It probably falls most nearly into the "reaction" class if we accept the loose use of that term which classes the Parsons type as a "reaction" unit.

Rate of Evaporation for Scotch and Watertube Boilers

Q.—What is reasonably good actual evaporation for a Scotch boiler generating steam at 180 pounds and a watertube boiler generating steam at 250 pounds? Can a feed pump be relied upon to measure the water fed to a boiler if we count strokes and know the pump dimensions? S. O. L.

A.—Actual evaporation of from 9 to 10 pounds per pound of coal of about 14,000 B. T. U. calorific value and natural draft is good for the Scotch boiler, and 9 to 10 pounds per pound of steam is good for general operation of the watertube boiler with moderate drafts. The feed pump is an erratic and inaccurate meter for the feed water, as the length of stroke varies and the slip varies in a given pump. Moreover, estimates of slip depend usually upon tests upon other pumps than the one in use and mechanical adjustment affects this factor enormously.

Test for Steam Consumption of Feed Pump

Q.—I want to test out the steam consumption of a feed pump here without going too elaborately into it and without any more expense than necessary. I have thought that I might break the exhaust line and discharge directly into a barrel of cold water, which I could weigh before and after. Do you think this would give me a reasonable estimate of it? Assist. Eng.

A.—If the feed pump is of moderate size, it is probable that the barrel of cold water will have insufficient condensing capacity to give reasonable accuracy. A large barrel will hold 55 gallons, which would weigh about 460 pounds of fresh water and 470 pounds of salt. If this were drawn at a temperature of 50 degrees Fahrenheit and we would condense a temperature of 180 degrees Fahrenheit, it would absorb approximately $180 - 50 = 130$ B. T. U. per pound of water, or a total of $470 \times 130 = 61{,}000$ B. T. U. The heat given up by one pound of steam at atmospheric pressure (with a quality assumed of .90) is approximately the heat contents of the steam from the steam charts, minus the mean heat of the condensate, or $1{,}052 - 83 = 969$ B. T. U., so that the barrel of water would condense only $61{,}000 \div 969 = 63$ pounds of steam, which would be a very short run for an average pump, and the result would be open to question to possibly 10 percent with ordinary weighing. A feed pump 7 inches steam by 4 inches water by 10 inches stroke uses about 500 pounds per hour, and if a run as short as five minutes can be considered typical, and the accuracy above quoted is sufficient, the method will do.

Comparison of Engine Performance

Q.—If we have two triple expansion engines of about the same indicated horsepower and revolutions per minute, but one working on a boiler pressure of 260 pounds absolute and the other on a boiler pressure of 180 pounds absolute, is it fair to compare steam consumption, dry steam, or even B. T. U.'s per indicated horsepower per hour, as measures of efficiency of design and performance? It doesn't seem to me that it is, yet I do not know how to throw them on a basis which permits an equitable comparison. I should be greatly obliged if you would take up this point and give suggestions for doing it—provided, of course, that I am correct in my attitude as to the unfairness of comparison when the boiler pressures are so widely divergent. T. E.

A.—A comparison of engines on the basis of actual steam consumption given in pounds of steam used per indicated horsepower per hour is of no value unless qualified by a description of the "pound of steam," as the heat contents (which is really the energy available) differs enormously for a pound of steam at any given pressure dependent upon whether it is wet, dry, or superheated. The quotation of performance in terms of pounds of dry steam or B. T. U. per indicated horsepower per hour avoids this objection, and is correct as a thermal comparison or as a comparison of actual energy used to produce one indicated horsepower.

None of these, however, takes any cognizance of variations in external conditions or of the nearness to which the given unit approaches perfection in its field. Nearly every conception in engineering is relative, and a true comparison is properly one which takes account of the limitations which external conditions impose, therefore one of the best comparisons of engines is the ratio of the consumption in thermal units of the *ideal*, a Rankine engine, to that of the *actual* engine. This is variously called commercial efficiency, efficiency of performance, etc., and simply means the percentage of the ideal steam engine performance that the one under discussion has achieved. The Rankine, or ideal, engine would transform all the heat available by an adiabatic drop from the upper to the lower pressure into work and the expression for its efficiency is

$$\frac{H_1 - H_2}{H_1 - q_2}$$

where H_1 = heat contents at upper pressure.
H_2 = heat contents at lower pressure.
q_2 = heat contents of the liquid at lower pressure.

To illustrate by the case you cite of two engines of same general characteristics, but one operating on a cycle from 260 pounds absolute to, say, 2 pounds absolute, and the other from 180 pounds absolute to 2 pounds, using dry saturated steam at the upper pressure, the Rankine efficiency of the first is

$$\frac{1202 - 886}{1202 - 94} = 28.6 \text{ percent}$$

and of the second is

$$\frac{1195 - 904}{1195 - 94} = 26.4 \text{ percent.}$$

Therefore, for a fair comparison of performance, the lower pressure engine should be credited with this difference. That is, the consumption of the higher pressure engine should be augmented by

$$\frac{28.6 - 26.4}{28.6} = 7.7 \text{ percent}$$

to compare equitably the achievements of the designer, builder and operator in the final performance. Stated differently, a steam consumption of 14 *pounds* of dry steam per indicated horsepower per hour for the engine using steam at 260 pounds pressure, and a consumption of $14 \times 1.077 = 15$ *pounds* of dry steam per indicated horsepower per hour for the engine using steam at 180 pounds are exactly equal attainments to the ideal. Therefore it is desirable to reduce engine tests to a common cyclical efficiency before analyzing for commercial efficiency.

Shipbuilding and General Marine News

Contracts for New Ships—Marine Terminal Improvements—Recent Launchings—Improved Appliances—Personal Items

At present the United States for the first time in over half a century is not only building more merchant shipping than any other country, but the American output for the year 1916 will probably exceed that of all the rest of the world, says a recent report from the Department of Commerce. The report further states:

The most complete records of the world's shipbuilding, uniform for a period of years, are those published by Lloyd's Register, showing merchant vessels over 100 gross tons launched each calendar year, not including vessels built for rivers, barges, and other unrigged craft. For this reason Lloyd's figures are somewhat less than the Government returns for the United States, the Netherlands, Germany, and other countries with considerable river and canal navigation. Lloyd's returns for the calendar years 1912, 1913, 1914 and 1915 are printed below as the best measure of the effect of the European war on merchant shipbuilding, although changes in the case of the United States are not attributable to that cause. The world's output of merchant shipping during the calendar year 1913 was the largest recorded, and under normal conditions probably would not have been fully maintained for two or three years following. The returns below for 1914 closed with the end of July so far as Germany and Austria are concerned, as those countries have issued no shipping reports since the outbreak of the war.

Merchant Vessels Launched

The following table gives the gross tonnage of merchant vessels of 100 gross tons or over launched in the world during the calendar years 1912 to 1915, inclusive:

Where Built.	1912.		1913.		1914.		1915.	
	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.
United Kingdom.	712	1,738,514	688	1,932,153	656	1,683,553	327	650,919
British Colonies	84	34,790	91	48,339	80	47,534	31	22,014
Austria-Hungary	12	38,821	17	61,757	11	*a*34,335	(*b*)	(*b*)
Denmark	22	26,103	31	40,932	25	32,815	23	45,198
France	80	110,734	89	176,095	33	114,052	6	25,402
Germany	165	375,317	162	465,226	89	*a*387,192	(*b*)	(*b*)
Italy	27	25,196	38	50,356	47	42,981	30	22,132
Japan	168	57,755	152	64,664	32	85,861	26	49,408
Netherlands	112	99,439	95	104,296	130	118,153	120	113,075
Norway	89	50,255	74	50,637	61	54,204	59	62,070
Sweden	22	13,968	25	18,524	26	15,163	27	20,319
United States:								
Coast	144	194,273	182	228,232	84	162,937	76	157,167
Great Lakes	30	89,950	23	48,216	10	37,825	8	20,293
Other countries	52	46,654	83	43,455	35	*a*36,148	10	*a*13,641
Total	1719	2,901,769	1750	3,332,882	1319	*a*2,852,753	743	*a*1,201,638

a Returns not complete. *b* Returns not available.

Effect of War on Shipbuilding

The first five months of the war did not seriously affect the world's launching of merchant ships, outside of Belgium, France and Germany, although deliveries late in 1914 began to be slow in British yards. In 1914 the United States launched only 200,762 gross tons, compared with 276,448 gross tons in 1913, but the decrease was not a result of the war. The world's total in 1914, even with the Central Powers excluded for five months, was only 480,000 tons less than the world's maximum in 1913 and was above the recent average annual output.

The belligerent powers, which in 1913 launched 2,798,580 gross tons of merchant ships, launched only 769,875 gross tons in 1915. The neutral powers, outside of the United States, in 1913 launched 257,844 gross tons, and in 1915 launched 254,303 gross tons. Local causes led to a further reduction in the American output from 276,448 tons in 1913 to 177,460 tons in 1915. The total decline in the world's shipbuilding for 1914 and 1915, both compared with 1913, was 1,438 ships of 2,611,373 gross tons. To these totals should now be added the decreased output in shipyards for the first six months of 1916, which the Bureau of Navigation states would bring the total since the outbreak of the war in August, 1914, up to 3,500,000 gross tons, notwithstanding the present activity of American, Japanese and Dutch yards. The loss to international commerce through the decline in shipbuilding thus has been greater than the loss through the actual destruction of shipping, although the latter has fixed the world's attention because of the submarine attacks on passenger steamships Reports compiled by the New York *Journal of Commerce* (July 5, 1916) show that 1,346 ships of 2,713,996 gross tons were destroyed from the outbreak of the war to June 30, 1916.

Activity in the United States

Late in 1915 and early in 1916 belief that the European war would last three years led to an exceptional development of shipbuilding by the maritime powers not actively engaged in war. In the first six months of 1916 the United States launched and put into operation 192 ships of 228,016 gross tons (each over 100 tons)—more than the entire year's output for 1914 or 1915. On July 1, 1916, private American shipyards were building or had on order 385 steel merchant ships of 1,225,784 gross tons. The builders' returns indicate that of this tonnage 159 ships of 444,090 gross tons will be launched before December 31, 1916, thus indicating a total output by the United States for the twelve months of 351 steel ships of 672,106 gross tons. Various causes retard shipbuilding, especially in times of high pressure, and the output of steel ship tonnage during the current six months of 1916 may fall short of present indications. Wooden ships, however, not included in the Bureau of Navigation's monthly returns, will help to make good any shortage, as wooden ship building has revived considerably under the pressure of the times.

Shipbuilding in Japan and the Netherlands

The shipyards of Japan, according to Commercial Attaché Arnold's recent report, are fully occupied with work for two years, and have reluctantly been obliged to decline foreign orders in order to supply their own shipowners. The ships building for delivery this year number 50 of 189,450 gross tons, which will be more than double Japan's largest output in 1914. Japanese builders have contracts for 104 ships of 464,370 gross tons to be delivered in 1916, 1917 and 1918, the Osaka yard contracting to deliver 35 of 162,400 tons. Japan, however, is obliged to import steel and began negotiations in the United States in January, which have been carried out successfully and extended considerably the market for American steel products.

The shipyards of the Netherlands, according to recent reports of American officers, have contracted to build merchant ships at extraordinary prices practically up to their capacity for 1916, 1917, and into 1918. Ships thus building or ordered late in 1915 were reported at 71, of 251,750 gross tons. Delivery, however, seems to be somewhat slow, as during the first three months of 1916 only seven new ships, of 15,349 gross tons, were added to the Dutch seagoing merchant fleet, while in the same period the *Tubantia* (13,910 tons), the *Palembang* (6,673 tons), and others were sunk by submarines and drifting mines.

Output in Norway, United Kingdom, France, Italy and Germany

Norway's output of 85,000 tons in 1915 was the largest recorded and will doubtless be exceeded this year, as over a year ago Norwegians began to place large orders in American yards, some with a view to subsequent sale to Americans or others.

On March 31, 1916, the shipyards of the United Kingdom had under actual construction, according to Lloyd's' Register, 423 steel steamships, of 1,423,335 gross tons, many of which for some months have been nearly completed, but await materials. The dates of launch and completion in British yards are uncertain so long as yards are employed fully on naval construction and turning out war munitions for the allies. During the first three months of 1916 British yards launched only 69 steel steamers, of 80,561 gross tons.

French shipyards also are fully employed on naval construction and the manufacture of munitions, and French shipowners have made inquiries for tonnage from American builders. There is in France a considerable tonnage of merchant steamships partly built.

In December, 1915, the Italian shipyards had 12 steel steamships, of 82,482 gross tons, under construction, but the probable date of completion is not known. There are no returns from Austria-Hungary, and presumably shipbuilding has ceased under the Italian blockade of Trieste and Fiume.

Since the outbreak of the war Germany has printed no returns, and is supposed to be engaged in building submarines and other naval construction, repair, and munitions work. In December, 1913, the Germanischer Lloyd report showed 499 merchant vessels, of 906,851 gross tons, including river boats, canal boats, lighters, etc., were building in German yards, of which up to July 30, 1914, 89, of 387,192 gross tons, had been launched, so that in August, 1914, about 410 vessels, of 520,000 gross tons, were building or ordered in German yards. Cabled statements to the United States in July, 1916, from Hamburg-American and North German Lloyd authorities indicate that such merchant work as Germany has done since the outbreak of the war has been, with few exceptions, on the ships ordered late in 1913 and early in 1914.

Increase in American Shipbuilding During the Year

The Bureau of Navigation, Department of Commerce, reports 1,030 vessels of 347,847 gross tons were built in the United States and officially numbered during the fiscal year ended June 30, 1916, compared with 1,266 vessels of 215,711 gross tons during the fiscal year ended June 30, 1915.

The seaboard yards have built 35 large steel merchant steamers aggregating 191,859 gross tons, the largest merchant steel output in their history. Of these, 21 steamers are each over 5,000 gross tons, the largest being the steamship *H. H. Rogers,* of 10,050 gross tons, and 14 are between 3,000 and 5,000 gross tons each. The Newport News Shipbuilding & Dry Dock Company, Newport News, Va., built six of 40,329 gross; the Maryland Steel Company, Sparrows Point, Md., eight of 35,665 gross; the Union Iron Works, San Francisco, Cal., five of 32,665 gross; the New York Shipbuilding Company, Camden, N. J., seven of 32,164 gross; and the Fore River Shipbuilding Company, Quincy, Mass., four of 24,932 gross. The Newport News, Camden and Quincy yards were also engaged in naval construction.

Of these steel ocean steamers, twenty-four of 138,858 gross tons have been registered for foreign trade, eight of 34,386 gross tons enrolled for the coasting trade, one, the steamship *Pacific,* of 6,034 gross tons, was sold to Norwegians, and up to June 30 the two remaining had not been documented.

Of the relatively small output of the Great Lakes, eight vessels of 14,775 gross tons are each under 2,500 tons, built for the ocean trade, of which four are for foreign trade and one (*Morris Adler,* 2,481 gross) has been sold to Norwegians.

Following is the detailed statement according to material and power (gasoline included under steam) for the fiscal year ended June 30, 1916, compared with the previous fiscal year.

	Number.	1916, Gross Tons.	Number.	1915, Gross Tons.
Wood:				
Sailing	47	16,087	50	7,241
Steam	594	18,781	743	27,082
Unrigged	285	62,844	357	60,188
Total	926	97,712	1,150	94,511
Metal:				
Sailing	....	.....	1	27
Steam	86	245,212	68	120,385
Unrigged	18	4,923	7	788
Total	104	250,135	76	121,200
Totals:				
Sailing	47	16,087	51	7,268
Steam	680	263,993	811	147,467
Unrigged	303	67,767	364	60,976
Grand total	1,030	347,847	1,266	215,711

Progress of American Shipbuilding

Steel merchant vessels building or under contract to be built in private American shipyards at the beginning of the new fiscal year, July 1, 1916, according to builders' returns to the Bureau of Navigation, Department of Commerce, numbered 385 of 1,225,784 gross tons. The Senate Naval Committee on June 30 reported the naval appropriation bill, which has later been passed by the Senate, providing the largest naval building program in our history. The new battleships, battle cruisers, scout cruisers, and other types of warships and auxiliaries number 157 of approximately 855,000 tons displacement, to be built at an estimated cost of $588,000,000. Of these, 66 of about 382,000 tons displacement are to be begun as soon as practicable, and the remainder before July 1, 1919. For comparison, on June 30, 1914, British shipyards were building 90 warships of 592,545 tons displacement, of which 76 of 458,175 tons displacement were building at private yards.

Growth During Twelve Months

The usual growth of steel merchant shipbuilding in the United States during the past twelve months is shown by the following summery of (*a*) steel merchant ships building or under contract to be built in private American shipyards on July 1, 1915, and on July 1, 1916, and on the first day of the past five months, (*b*) new contracts for steel merchant ships entered into during the past five months, and (*c*) steel merchant ships built in the United States and officially numbered during those months.

Period.	Built or Under Contract.		New Contracts.		Vessels Completed	
	Number	Gross Tons	Number	Gross Tons	Number	Gross Tons
July 1, 1915..	76	310,089	....	.....	....	.....
Feb. 1, 1916..	230	901,371	20	61,136	6	31,329
Mar. 1, 1916..	244	945,798	107	151,296	5	23,394
Apr. 1, 1916..	360	1,037,856	20	51,011	6	12,915
May 1, 1916..	368	1,129,014	20	81,470	13	53,840
June 1, 1916..	372	1,147,534	39	114,530	10	39,940
July 1, 1916..	385	1,225,784	....	.....	....	.....
Total....	....	.....	206	459,443	40	161,418

For comparison, on March 31, 1916, private shipyards in the United Kingdom had under actual construction 423 steel merchant ships of 1,423,335 gross tons. As British shipyards are almost wholly engaged in naval construction and the manufacture of war munitions for the allies, merchant ship construction is slow, and during the first three months of 1916, only 67 steel steamers of 80,161 gross tons were launched. For further comparison, the entire world during the calendar year 1915, according to Lloyd's Register, launched 743 merchant ships of 1,201,638 gross tons, of which 84 of 177,460 gross tons were launched in the United States.

Two Year's Work

The report also shows the distribution of steel merchant shipbuilding among the private shipyards of the United States and, separately, the number and gross tonnage of the ships building or under contract which the builders expect to launch during the current fiscal year, ending June 30, 1917, and those which will not be launched before the fiscal year ending June 30, 1918. These dates are subject to the usual allowances for delays due to the several causes which affect steel industries. The urgency of the naval construction program may also prove a factor in the situation. Barring delays, builders expect to launch 327 steel ships of 927,893 gross tons during the current fiscal year and 58 ships of 297,891 gross tons during the following fiscal year.

Shipbuilding Contracts

Contracts are in suspense for about fifty steamships for 1918 delivery. They are temporarily held up while awaiting agreement as to prices and time of delivery of the necessary steel plates and shapes.

The Wm. Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., has received a contract from the New York & Cuba Mail Steamship Company (Ward Line), New York, to build two passenger and freight steamers of 12,000 tons displacement each.

The American Shipbuilding Company, Cleveland, Ohio, has received a contract to build five large freight vessels for 1917 delivery. Two of these are for M. A. Hanna & Company, Cleveland, Ohio.

The Pusey & Jones Company,, Wilmington, Del., is reported to have received orders for twelve additional ships. Six are to be 225 feet long and six are to be 300 feet in length. There are already eight vessels under construction in this yard.

The Seattle Construction & Dry Dock Company, Seattle, Wash., has received a contract from the New York & Cuba

Mail Steamship Company to build two freight steamers of 6,000 tons displacement each.

The Skinner & Eddy Corporation, Seattle, Wash., has received a contract from the Standard Oil Company, San Francisco, Cal., to build two 430-foot oil tanker steamships, to be equipped with General Electric turbines.

It is reported that the Willamette Iron & Steel Works and the Northwest Steel Company, Portland, Ore., have received a contract to build another steel steamship, to be a duplicate of the four already under contract for Capt. C. Hannevig, New York.

The St. Helens Shipbuilding Company, St. Helens, Ore., has received a contract from the California & Oregon Lumber Company, Brookings, Cal., to build a large lumber schooner to be fitted with Bolinder oil engines.

M. M. Davis & Sons, Solomons Island, Md., have received a contract to build a 200-foot wooden freight steamer for the Baltimore & Carolina Steamship Company, Baltimore, Md.

The Harlan & Hollingsworth Corporation, Wilmington, Del., is building a steel freight ship for the Baltimore & Carolina Steamship Company.

The Ellicott Machine Corporation, Baltimore, Md., is building three steel tugs.

The Merrill-Stevens Company, Jacksonville, Fla., has received a contract from the Boston Molasses Company, Boston, Mass., to build a 139-foot steel steam-driven barge.

The Merrill-Stevens Company is building two barges for the Cuba Distilling Company, Havana, Cuba.

Richard T. Green Company, Chelsea, Mass., is building a four-masted schooner 200 feet long.

George Lawley & Sons Corporation, Neponset, Mass., has received a contract from the Navy Department, Washington, D. C., to build a gasolene patrol boat 45 feet long.

The Luders Marine Construction Company, Stamford, Conn., has a contract from the Navy Department to build a 65-foot motor patrol boat.

The Hanlon Shipyard, Oakland, Cal., has a contract from the Western Fuel Company, San Francisco, Cal., to build two barges with a capacity of 3,500 tons each.

A. C. Brown & Son, Staten Island, N. Y., have a contract to build a wooden steam lighter for the Old Dominion Steamship Company, New York.

A. C. Brown & Son have received a contract to build a 91-foot wooden tug for the Gillen Lighterage Company, New York.

The John Wilson Shipyard, Seattle, Wash., has received a contract from the Tacoma Dredging Company for a 110-foot dredger, to cost $70,000.

The Seattle Construction & Dry Dock Company, Seattle, Wash., has recently secured a contract for two new steel freighters for foreign service.

The Great Lakes Engineering Works, Ashtabula, has recently received a contract from Mr. Aug. Stephanson, Christiania, Norway, for a 4,150 ton deadweight cargo steamer. The vessel is 253 feet long by 43 feet 5 inches beam and 27 feet 5 inches depth, and will cost $450,000.

The American Shipbuilding Company, Cleveland, Ohio, has recently received orders for four full-canal-size ships for salt water service, for delivery during the first half of 1917.

The Seaborn Company, Tacoma, Wash., is starting work on two lumber vessels, both to be equipped with oil or gas engines.

The Beaumont Shipyard Corporation, Beaumont, Texas, has received an order from the Orange Maritime Corporation for the construction of a three-masted schooner, 168 feet long by 36 feet 6 inches beam by 15 feet depth, with a carrying capacity of 700,000 feet of lumber, or about 1,500 tons. The vessel is intended for the West Indian trade.

The Robins Dry Dock & Repair Company, Erie Basin, Brooklyn, N. Y., recently lengthened the freight steamer *George E. Warren*, of Boston, 52 feet, adding about 1,000 tons to her carrying capacity.

The Union Iron Works, San Francisco, Cal., recently completed the lumber steamer *Daisy Matthews* at their Oakland plant. This vessel will have a carrying capacity of a million feet of lumber and her first voyage will be to Gray's Harbor, Wash.

The General Electric Company, Schenectady, N. Y., has received a contract from the United States Navy Department for the construction of propelling machinery for the scout cruiser *Salem*.

The Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa., has received a contract from the United States Navy Department for propelling machinery for two naval destroyers.

The American Bridge Company, a subsidiary of the United States Steel Corporation, recently received orders for the construction of seven car floats or barges for the Lehigh Valley Railroad, to be used in New York harbor.

The Spedden Shipbuilding Company, Baltimore, Md., has laid the keel for a tugboat for the Northern Transportation Company, of Baltimore. The new tug will be 150 feet long overall and will have a bunker capacity of 330 tons.

The Spedden Shipbuilding Company, Baltimore, Md., is rebuilding the sidewheel steamers *Maryland* and *Capital City* into coastwise barges.

A steel oil tank barge was recently launched from the yards of the Spedden Shipbuilding Company, Baltimore, Md., for the Standard Oil Company for use in Norfolk harbor. The barge is 64 feet 3 inches long, 16 feet 8 inches beam and 5 feet deep, with four oil compartments.

The Newport News Shipbuilding & Dry Dock Company, Newport News, Va., was the successful bidder for making permanent repairs to the Dutch steamer *Willem van Driel, Jr.*, recently badly damaged by fire.

Shipyard News

The Fore River Shipbuilding Corporation, Quincy, Mass., has recently completed what is said to be the largest ship plate and angle shop in the world. The building is of brick and steel construction, 769 feet long by 188 feet wide and 60 feet high, covering an area of 3¼ acres. The second story of the building contains the mold loft, 93 feet by 605 feet, a sheet metal working shop and storage space.

At the Maryland Steel Company's plant, Sparrows Point, Md., large additions are soon to be made costing upwards of $30,000,000. Although details are temporarily withheld, it is understood that the marine department of the plant will be materially enlarged.

The Willamette Iron & Steel Works, Portland, Ore., is about to erect a boiler shop costing $12,000.

The Western Dry Dock & Shipbuilding Company, Port Arthur, Ont., is building a pattern and electrical shop, costing $25,000, to replace one recently destroyed by fire.

The Sydney Foundry & Machine Company is proposing to build dry docks and a ship repairing plant at Sydney, Nova Scotia.

The Seattle Construction & Dry Dock Company, Seattle, Wash., recently taken over by the Todd Shipyards Corporation, New York, will be greatly enlarged and improved by the addition of five new shipbuilding ways and a new steel floating dry dock and the enlargement of the present dry dock.

The Winslow Marine Railway & Shipbuilding Company, Seattle, Wash., has recently been organized with a capital stock of $600,000 and has taken over the shipbuilding plant of the Hall Bros.' Marine Railway & Shipbuilding Company, Winslow, Wash. The company will engage in wooden shipbuilding and ship repairing. C. C. Lacey, of Seattle, Wash., formerly marine superintendent of the Great Northern Steamship Company, will be manager of the new company.

The Chester Shipbuilding Company, Ltd., Chester, Pa., which bought the late John Roach Shipyard a year and a half ago, and now has orders for fourteen vessels, is planning the construction of two additional shipways, which will bring the total number at the yard up to seven, and also the construction of a 40 by 200 foot fitting-up wharf.

The New York Shipbuilding Company, Camden, N. J., is building a one-story extension to its machine shop, 131 feet by 169 feet.

It is reported that the Union Iron Works, San Francisco, Cal., is planning to spend about $1,000,000 in enlarging the nearby shipyard which it has recently purchased.

The Atlantic Coast Company, of which Walter D. Noyes, Boston, Mass., is president and Lewis K. Thurlow, Boston, is treasurer, has leased the shipbuilding plant of Washburn Brothers at Thomaston, Me., and will immediately begin work on a four-masted schooner for Crowell & Thurlow, Boston, Mass.

The Philadelphia Ship Repair Company, Philadelphia, Pa., is planning to greatly enlarge its plant. F. J. McDonald, president of the company, states that work will soon be begun on the installation of a large floating drydock, machinery, etc.

The Todd Shipyards Corporation has been incorporated at Albany, N. Y., to take over the Robins Dry Dock & Repair Company, Brooklyn, N. Y., and the Tietjen & Lang Dry Dock Company, Hoboken, N. J. H. N. Dawson, F. W. Morrell and F. D. Riedlan, all of Brooklyn, are among those interested in the new concern.

The St. John Dry Dock & Shipbuilding Company, Ltd., has been organized in St. John, N. B., with a capital of $1,000,000, and is planning extensive building operations, the nature of which has not yet been divulged.

Lloyd W. Josselyn, librarian of the city of Jacksonville, Fla., writes MARINE ENGINEERING that several Jacksonville business men are planning to establish a shipbuilding plant with the intention of building large wooden schooners.

Preliminary work for the establishment of shipbuilding yards at Poplar Island on the Fraser River, B. C., has been undertaken by the Westminster Marine Railway Company, New Westminster, B. C. The company proposes to build a plant on the island to cost $70,000 and to install $15,000 worth of machinery.

The League Island Navy Yard, of Philadelphia, Pa., will be developed into a great naval base, according to statements by Franklin D. Roosevelt, Assistant Secretary of the Navy. The yard is assured of a new dry dock and it is probable that the proposed million-dollar chemical laboratory will be established at the yard.

Large American Shipyard to be Established on the Potomac River

Plans are being perfected by the recently organized International Steel & Shipbuilding Company, of New York and Washington, for the erection of a shipbuilding plant at Quantico, Va., which shall rival in size and output the leading shipyards in the United States.

The site selected for the new shipyard comprises 55 acres with a frontage of 2,400 feet, on the Potomac River. At this point the river is about three miles wide and there is a depth of water of from 35 to 40 feet just off the shipyard site. As the yard is located only 35 miles down the Potomac River from Washington and about 18 miles from Fredericksburg, Va., the site is accessible by rail connection to the principal Southern railroads and is bounded by their tracks.

Although the water frontage of the new yard will provide space for as many as twenty-four shipbuilding ways, only six will be erected at the start. At the same time, a main ship fitters' shop, 500 feet by 150 feet, will be erected and a mold loft and office building, 300 feet by 75 feet, and a machine shop 140 feet by 70 feet. The machinery will be operated by electric power secured from nearby power plants and the main shop will be equipped with three moving cranes, one of 10 tons' capacity and two of 5 tons' capacity. The six building ways will be equipped at first with temporary cantilever traveling cranes, although it is the intention of the company finally to fully equip the building ways with overhead traveling cranes.

It is understood that contracts have been secured for the construction of six general cargo steamers, each of 5,000 tons deadweight carrying capacity.

The directors of the new company are C. L. Ford and T. S. Stanton, of the Southern Boiler & Tank Works, Memphis, Tenn.; Thomas J. Shea, Portland, Ore.; G. A. Garrett, Washington, D. C.; James J. Shirley, manager of the foreign department of T. A. Gillespie Company, New York; Hugh McIsaac, vice-president Publicity Corporation, Washington, D. C., and H. T. Winfield, attorney, Washington, D. C.

The officers of the company are: Thomas J. Shea, Portland, Ore., president; C. L. Ford, vice-president and general manager; Hugh McIsaac, Washington, D. C., secretary and treasurer; James J. Shirley, New York, vice-president.

While the main offices and plant for the new company will be at Quantico, Va., offices will also be maintained at 50 Church street, New York, and Munsey Building, Washington, D. C.

Plant of the Sun Shipbuilding Company at Chester, Pa., Rapidly Nearing Completion

The Sun Shipbuilding Company, Third street and Delaware River, Chester, Pa., is rapidly completing the foundation work for shipbuilding ways and new shops for the yard. Concrete foundations for five shipways have already been started and two more will be begun at an early date. The foundations for the fabricating shops and ship sheds have been completed and it is expected that the buildings will be completed, the ways ready and much of the machinery and equipment installed by September 1. The plant covers a 60-acre tract. The main fabricating shop will cover 5 acres. A large and completely equipped boiler shop is also to be erected on the shipyard property and the plant of the Robert Wetherill & Co., Inc., which is owned by the shipbuilding company, and which will be used for the manufacture of machinery and engines, will be considerably enlarged. The present boiler shop equipment at the Wetherill plant will be moved to the new shop in the shipyard and all of the boiler and tank work will be done at that plant.

At the first meeting of the full board of the Sun Shipbuilding Company, held on July 5, Messrs. J. Howard Pew, Joseph N. Pew, Jr., William C. Sproul, Robert Haig and J. A. Sinn were appointed members of the executive committee. Robert Haig, formerly chief engineer for Lloyd's, will be general manager of the engineering department of the Sun Shipbuilding Company and president of Robert Wetherill & Co., Inc. Mr. Haig's principal assistant will be Henry J. Klaer, who will remain at the Wetherill plant with James H. Garthwaite as general manager of that plant. J. A. Sinn, formerly of the Fore River Shipbuilding Corporation, Quincy, Mass., has been appointed general manager of the hull construction and shipyard department. A. A. Howitz, formerly of the New York Shipbuilding Company, Camden, N. J., has been appointed chief engineer and W. Cunliff, formerly of the New York Shipbuilding Company, will be assistant chief engineer of the Sun Shipbuilding Company. A. B. Saunders, formerly of the New York Shipbuilding Company, Camden, N. J., has been appointed naval architect of the Sun Shipbuilding Company.

Large Oil Tanker Equipped with Fire Tube Superheaters

While there are about fifteen hundred steamers, representing over 2,000,000 horsepower, sailing from foreign ports equipped with firetube superheaters, the recent launching of the S. S. *Pearl Shell* at the shipyards of Harlan & Hollingsworth Corporation, Wilmington, Del., represents the first installation in a new steamer built in this country.

The *Pearl Shell,* an oil tanker, is to be operated by the Shell Oil Company, of San Francisco, and will sail out of New York harbor for the present at least. The vessel is over four hundred feet long, with a gross tonnage of over 5,600. She is equipped with three Scotch marine boilers fitted with Locomotive Superheater Company firetube superheaters, supplying superheated steam to triple expansion engines developing 2,400 horsepower.

The superheater was applied to the *Pearl Shell* after the purchasers had determined, to their own satisfaction, the economies and reliability in operation of a superheater of the same design, applied to one of their existing steamers of approximately the same size. They have also contracted for sufficient superheater equipment to convert five more of their existing ships.

Search for Fireproof Material for Deck Construction

The Bureau of Standards, Department of Commerce, in connection with a general study of fire-resisting materials, is considering among other phases of the subject the development of a fire-resisting material for use in constructing, in whole or part, the deck structures of excursion and passenger steamers. So far as may be applicable, the material when developed would also be considered in relation with other marine uses.

The Bureau of Standards would be glad to receive from manufacturers samples of such materials as they consider suitable for the purpose.

CORRECTION.—Under the illustration of the steamship *Eurana* on page 339 of the July issue, the caption, "S. S. *Eurana;* Equipped with De Laval Turbine Reduction Gears," is misleading, as, while the vessel is fitted with De Laval steam turbine-driven auxiliary units, it is not equipped with De Laval gears. The vessel is actually equipped with speed-reducing gears for propulsion, but they are not of the De Laval manufacture. The auxiliaries, however, include two 2-inch, 3-stage boiler feeders, each capable of supplying 100 gallons per minute, against 210 pounds pressure when driven at a speed of 3,450 revolutions per minute by a 38-horsepower velocity stage-impulse turbine, and two 10-kilowatt, 120-volt, direct-current generators, each driven by a De Laval turbine similar to those installed for driving the boiler feed pumps. The caption under the illustration referred to, therefore, should have read, "S. S. *Eurana,* equipped with De Laval steam turbine-driven auxiliaries."

Craig Engine Ordered for Large Auxiliary Schooner

An order for a 400 brake horsepower Diesel type engine to be installed in a large auxiliary schooner was recently placed through Messrs. Cox & Stevens, naval architects, New York, with the James Craig Engine & Machine Works, Jersey City, N. J. Two other makes of engines were ordered at the same time for vessels belonging to the same owner, but the Craig type was selected for the most powerful installation.

This schooner's main dimensions will be 239 feet by 40 feet beam and 19 feet draft loaded, and she will have a deadweight capacity of 2,000 tons. A speed of about 8 knots is contemplated with a Craig-Diesel type engine of 400 brake horsepower. Of the directly reversible type, this engine will have eight cylinders and will operate at about 240 revolutions per minute.

It is proposed to have the schooner in the transatlantic trade until the steamships overcrowd the Atlantic routes, and thereafter probably the vessel will be diverted to South American voyages. Normally her engine will be kept in operation, all possible additional benefit being derived from the wind, and the engine will only be shut down when there is a good stiff, favorable breeze to keep the vessel bowling along on her course at 8 knots or more.

A Craig-Diesel type engine of this power, it is claimed, will consume only about 14 barrels per day of 24 hours when operated at the maximum number of revolutions of the propeller wheel, but the regular practice of marine engineers being to operate the engines at very slightly less than full power, with practically no noticeable variation in the speed of the ship as a consequence thereof, the daily consumption can be reckoned at about 12 barrels. Under similar conditions a steamer would burn about 8 tons of coal per day.

Large Orders for Welin Davits

The United Fruit Company has placed orders with the Welin Marine Equipment Company, Long Island City, N. Y., for re-equipment of their whole fleet of passenger ships with Welin davits. Three of these ships, the *Pastores, Tenadores* and *Calamares,* were equipped with this type of davit when built and the equipment is proving so satisfactory that the United Fruit Company has placed orders to install similar equipment on all their ships.

The Welin Company also recently received davit orders for two passenger ships building for the Savannah line at the Harlan & Hollingsworth yards; for eight additional oil and freight ships building at the Union Iron Works, at San Francisco; for five additional ships building at the Chester Ship Building Company's plant; for four ships building for the Texas Steamship Company at their own yard; and for the steamship *Havana,* of the Ward Line, besides several other orders, including a number of ships of the Grace Line.

The boat department of the Welin Company is equally busy. Large orders for power lifeboats have been received from the United Fruit Company; also large orders for Lundin lifeboats from the Eastern Steamship Corporation of Boston. The Peninsular & Occidental Steamship Company, operating on the Gulf, is also adopting this type of boat.

Altogether, the Welin Marine Equipment Company has booked davit orders during the last six months to equip 116 ships, and many of these ships are also being equipped with Lundin lifeboats. In addition, standard lifeboat equipment and raft equipment is being furnished for about an equal number of ships, all of which tends to show the high quality and efficiency of the equipment furnished by this company.

Recent Launchings

The motor tank ship *Bramell Point,* under construction at the yards of the Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md., for the Vacuum Oil Company, New York, was launched on July 4.

The Merrill-Stevens Company, Jacksonville, Fla., launched on June 30 the twin screw gasoline lighthouse tender *Palmetto,* 90 feet long by 22 feet beam by 8½ feet depth, designed for service on the coast of North and South Carolina, Georgia and part of Florida.

The William Cramp & Sons' Ship & Engine Building Company, Philadelphia, Pa., launched on June 28 the oil tanker *J. M. Danziger,* of about 7,100 gross tons, which is under construction for the Petroleum Transportation Company, New York.

The Fore River Shipbuilding Corporation, Quincy, Mass., launched on July 20 the submarine *Isaac Peral,* which is being constructed for for the Spanish Government. The vessel is about 185 feet long, of 957 tons displacement.

The Manitowoc Shipbuilding Company, Manitowoc, Wis., launched on July 22 the steel steamer *Surveyor,* building for the United States Coast and Geodetic Survey.

PERSONAL

E. M. Salmon, formerly on the staff of the chief engineer surveyor of Lloyd's in London, has been appointed principal engineer surveyor of Lloyd's Register for the United States and Canada, with headquarters in New York.

J. A. Eden, Jr., has severed his connection with the Bausch Machine Tool Company, Springfield, Mass.

Holden A. Evans, formerly vice-president and general manager of the Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md., has been elected president of the company. Clement C. Smith, Milwaukee, Wis., has been elected vice-president; J. M. Willis, Baltimore, second vice-president; Edwin W. Poe, Baltimore, secretary, and George Allison, Baltimore, treasurer.

George A. Anthony, for eighteen years marine engineer in the quartermaster general's office of the Army Department, Washington, D. C., has resigned to engage in private business.

George E. Emmons, for twenty years plant manager of the General Electric Company, Schenectady, N. Y., was recently elected vice-president of the company.

H. Jasper Cox, formerly attached to the Lloyd's chief ship surveyor's staff in London, has been appointed assistant to the chief surveyor of Lloyd's Register for the United States and Canada, with headquarters in New York.

L. H. Mesker has been appointed sales manager of the Kearney & Trecker Company, Milwaukee, Wis., which manufactures the Milwaukee milling machines.

OBITUARY

John F. Hoffmire, Jr., superintendent and treasurer of the Roberts Safety Water Tube Boiler Company, Red Bank, N. J., died recently at his home in Red Bank, aged forty-seven.

William T. Fickett, retired shipbuilder, died at his home in Brooklyn, N. Y., on July 7, aged seventy-two.

Charles W. Moody, one of the men who helped build the ironclad vessel *Merrimac* for the Southern Confederacy, died on July 18 at New London, Conn., aged eighty-six.

Ernest C. Bliss, president and director of Bliss, Dallett & Co., of New York city, operators on the Red D Line of steamships, died suddenly at Manchester, Vt., on July 22.

Commodore Fred B. Dalzell, vice-president of the New York Boat Owners' Association, head of the Fred B. Dalzell Towing Company, Inc., and one of the best known steamship men on the Atlantic coast, died suddenly at his summer home in Amityville, Long Island, on July 16, aged fifty-four. For twenty-five years Commodore Dalzell was on the executive committee of the National Board of Steam Navigation and for two years its president. He was also chairman of the executive committee of the Board of Governors of the New York State Nautical School, chairman of the committee on rivers and harbors of the Maritime Exchange, and active in the affairs of the Chamber of Commerce of the State of New York, the New York Board of Trade and Transportation, the Merchants' Association, and the National Rivers and Harbors Congress.

Thomas Minor Lincoln, of New York city, whose death was noticed in our May issue, was born at Lewisburg, Pa., on September 1, 1854. During the Civil War he lived in Cincinnati, Ohio, and later attended public school in Boston, Mass., and the City College of New York. Before completing his college course, he left to enter the employ of the Pacific Mail Steamship Company. He was purser of the steamship *Georgia* of this line when it was wrecked in the Straits of Magellan, and commanded a boat that was rowed forty miles to Punta Arenas for help. He returned to the United States by the west coast of South America and Panama, where he inspected the railway and canal route for the company. He then entered the employ of the Clyde Steamship Company as purchasing agent, and later became, in addition, chief draftsman and assistant engineer of the line. He was obliged to resign in 1895 on account of ill health, after twenty-one years of faithful service. After his resignation he devoted himself to genealogy and historical research. Mr. Lincoln was a member of the Society of Naval Architects and Marine Engineers, the American Society of Naval Engineers, and numerous historical associations and fraternal orders.

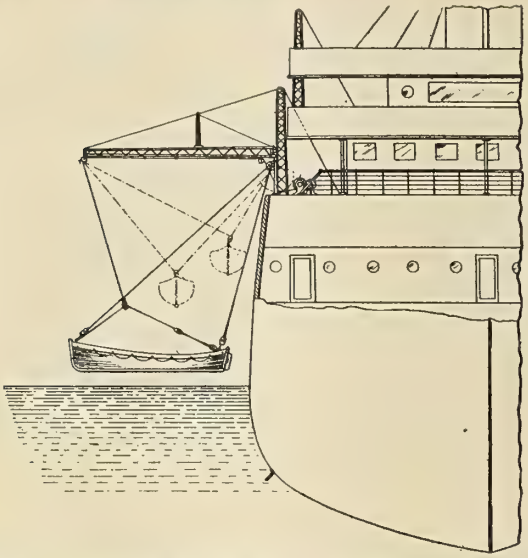
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,152,678. LAUNCHING APPARATUS FOR BOATS. SIGFRID NELSON WESSBERG, OF BROOKLYN, N. Y.

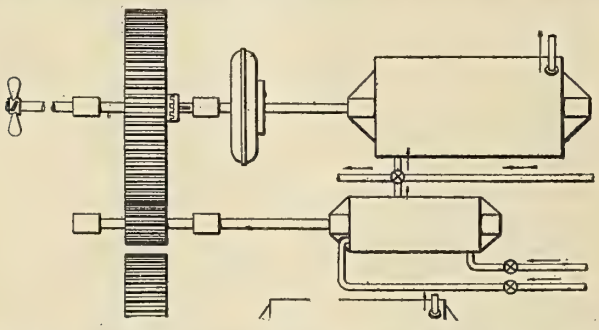
Claim 1.—A launching apparatus comprising a derrick located between tiers of boats on the deck of a ship and having a swinging boom adapted to extend beyond the ship's side more than the length of the boat to be launched, a lowering tackle on said boom, davits for supporting the boats, davit blocks and tackle connected with said davits and



adapted to be connected with the boat, a boat hung on said davit blocks, a detachable span connected to each end of said boat and provided with means midway its length for connection with the lowering tackle on the boom, one end of said span including a block and tackle whereby said end may be lengthened while the boat is being lowered. Five claims.

1,166,756. TURBINE POWER PLANT. HERMANN FOTTINGER, OF ZOPPOT, NEAR DANZIG, GERMANY.

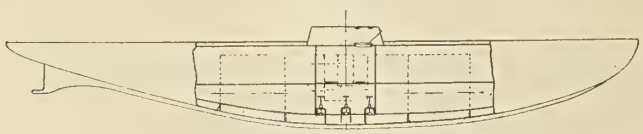
Claim 1.—A turbine plant including in combination a high pressure, high speed turbine, a low pressure, low speed turbine mounted for independent rotation, a driven shaft, mechanical gearing for transmitting



power from said high pressure turbine to said shaft and a hydraulic power transmitter for delivering power from said low pressure turbine to said shaft. Seven claims.

1,175,219. SUBMARINE BOAT. JOSEPH BARRAJA-FRAUENFELDER, OF BRIDGEPORT, CONN., ASSIGNOR TO THE LAKE TORPEDO BOAT COMPANY OF MAINE, OF BRIDGEPORT, CONN., A CORPORATION OF MAINE.

Claim 1.—A submarine or submersible boat, having a middle main ballast-tank the center of volume of which is in substantially vertical alinement with the center of gravity and center of buoyancy of the

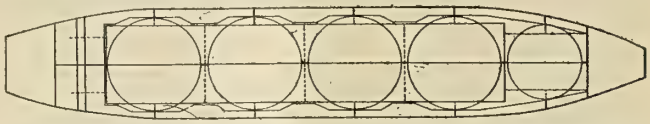


boat, forward and after main ballast-tanks having their center of volume in substantially the same longitudinal vertical plane with the center of gravity and center of buoyancy of the boat, auxiliary tanks arranged at the sides of the boat, and final adjusting tanks arranged in said auxiliary tanks and final adjusting tanks being in the same transverse plane with the center of gravity of the boat. Eight claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn place, W. C., London.

15,748/15. TANK STEAMERS. SIR W. G. ARMSTRONG, WHITWORTH & CO., LTD., AND R. S. WHITE, OF THE WALKER SHIPYARD, NEWCASTLE UPON TYNE.

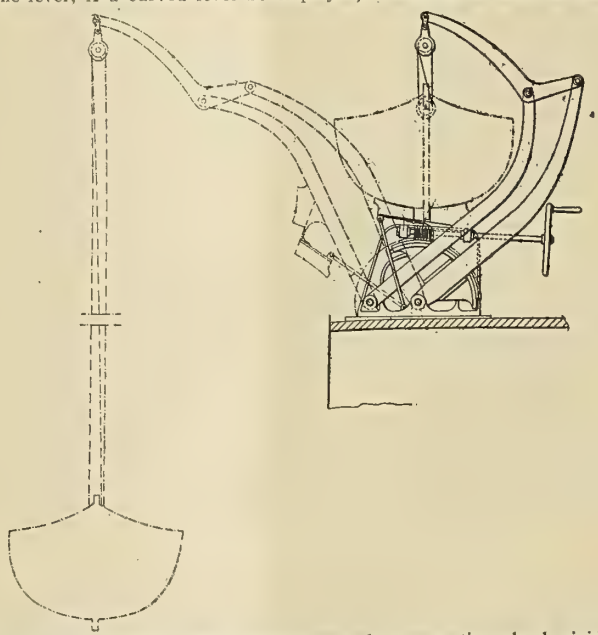
This invention relates to tank steamers such as are used for carrying liquid in bulk of the type in which bottomless tanks are connected to and extend upwards from the bottom plating of the ship. Its object is to furnish a vessel of simple and strong construction in which as much space as possible shall be available for carrying the cargo. According to this invention each bottomless cylindrical tank is supported on two longitudinal girders and on two transverse girders or floors (or on a keelson connected thereto), shelves forming the bottom of the tank where it overlaps the girders, and plates being secured to the longitudinal and transverse girders outside the cylindrical walls of the tanks.



Each cylindrical tank is thus in communication with a rectangular space extending right down to the bottom of the ship, and bounded by the two longitudinal girders and by two transverse girders, but otherwise unobstructed. Auxiliary tanks are also provided, each being bounded by the side of the vessel, by the sides of two main tanks, by two transverse partitions and by a central longitudinal partition.

5,370/15. DAVIT FOR MANIPULATING SHIPS' BOATS. M. F. TEMPLE AND G. H. GRAHAM, BOTH OF LONG ROW, THRIFT STREET, SOUTH SHIELDS.

The drawing is an end view showing a davit in its inboard position in full lines and its outboard position in dot-and-dash lines. The davit consists of a curved crank lever pivoted to the upper end of a second lever, which may be curved as shown, or straight, fulcrummed at the outboard side of base plate, which forms the attachment of the device to the ship's deck. The lever may be single, or may be formed of two plates parted by distance pieces, or of two plates riveted together for a portion of their length to form a forklike lever, distance pieces if desired, being arranged in the fork portion of said lever. The longer member of the lever is provided with an eye or eyes at its furthest extremity for carrying the boat falls or tackle, while the shorter arm is pivoted to the upper end of a third lever, which may be curved as shown, or straight, mounted on a shaft pivoted in bearing on the base plate aforesaid, and inboard relatively to the lever. Fixed to the lever so as to move therewith is a toothed quadrant gearing with a worm or endless screw, the spindle of which is mounted in bearings on the standard on base plate, and operated by a hand wheel or like device, so that by rotating the quadrant by the worm aforesaid the lever may be moved from its position leaning inboard, which is normal when the boat rests upon the chocks, to an outboard position when the boat is to be launched or lowered clear of the ship's side. The curve of the lever, if a curved lever be employed, is such as to clear the boat



when stowed and said lever has one part of a supporting chock rigidly attached to it to receive said boat when stowed, while the other and outboard half of said chock is hinged thereto and supported and actuated by a link or stay pivoted to the base plate. The base plate is arranged to carry each davit as a separate structure, thus allowing them to be fitted to any required span. To prevent any strain or side movement and to assist in the more perfect working, the quadrant is provided with a boss which carries a pin riding in an arc-shaped slot in the standard, a nut on the outer end of said pin assisting in maintaining the quadrant's even working. In operation the partial rotation of the quadrant by the rotation of the worm moves the lever outwards, which carries outboard with it the lever which supports the cranked lever bearing the boat into the position shown in dot-and-dash lines. At the same time the shorter arc described by the link connecting the base plate with the hinged half of the chock, causes said hinged half to clear the boat during its outward movement. The endless screw or worm being of small pitch acts as a regulator and brake to prevent slipping.

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Progress of American Shipbuilding

STEEL merchant vessels building or under contract to be built in private American shipyards on August 1, 1916, according to builders' returns to the Bureau of Navigation, Department of Commerce, numbered 389 of 1,260,978 gross tons, an increase of four vessels and 35,194 tons over the returns for July 1. Barring delays, the builders expect to launch during the current fiscal year 340 vessels of 1,004,523 gross tons.

Effect of War on Shipbuilding

STATISTICS showing the number and tonnage of steam vessels owned by the various nations of the world, contained in the new issue of Lloyd's Register, indicate that war losses and the curtailment of new production have caused a slight reduction in the total since the beginning of hostilities. The number of vessels listed under date of June, 1914, was 24,444, with an aggregate gross tonnage of 45,403,877, as compared with 24,132 vessels with an aggregate gross tonnage of 45,247,724 on June 30, 1916. Lloyd's figures show that the United States has made the greatest gain reported by any nation. This increase has been confined entirely to ocean-going vessels, which have increased in number from 172 and in tonnage by 825,627. To offset this increase, there has been a slight decline in the number and tonnage of American lake vessels, some of which have been withdrawn for ocean service. Taking these losses into consideration, the gain of the American merchant marine has been 147 steamships of 786,137 gross tons.

Who Will Build the Ships?

THE naval programme authorized by Congress calling for the construction of no less than 157 vessels of approximately 855,000 tons displacement, 66 of which of about 382,000 tons are to be begun as soon as practicable, and the remainder before July 1, 1919, fittingly expresses the will and desire of the majority of the citizens of the United States for the liberal and adequate development of the nation's first line of defense. It should be remembered, however, that the expeditious and successful fulfilment of this programme rests largely upon the shipbuilding facilities made available and maintained by private enterprise. The strength of a nation at sea rests not alone in its ships, but also in its facilities for building and repairing ships.

The Forerunner of the Deutschland

REMARKABLE as the exploits of the merchant submarine *Deutschland* have seemed to the general public, nevertheless those who have followed the experimental work and development of submarine vessels for the past quarter of a century will recall that as long ago as 1897 Chesapeake Bay was the scene of far more significant, if less spectacular, submarine exploits. In that year the first submarine boat to be equipped with an internal combustion engine was built and successfully operated in Chesapeake Bay. This was the *Argonaut,* a vessel 36 feet long and 9 feet in diameter, propelled by a 30-horsepower gasoline (petrol) engine. She was designed and built by Mr. Simon Lake and in January of the following year Mr. Lake navigated the *Argonaut* in stormy weather, under her own power without escort, from Baltimore to New York. It was from the work of Mr. Lake and in accordance with his designs that Germany began her development of the submarine which has culminated in the construction and successful operation of the *Deutschland.*

Navy Department Adopts Geared Turbines for Destroyers

IT has recently been announced that the Navy Department intends to re-engine several naval vessels now in service, which, when they were constructed, were equipped with direct connected turbines. The first two to be so reconstructed will be the destroyers *Henley* and *Mayrant.* These are to be equipped with geared turbine units for which contracts have been placed with the Westinghouse Machine Company, East Pittsburgh, Pa.

Geared turbines have been adopted, due to the fact that they are lighter and take up less space than direct connected units, and also due to the fact that the steam consumption is materially reduced at all speeds and especially at cruising speeds. This decrease in steam consumption means not only a reduction in fuel consumption but also an increase in the steaming radius, which is an important feature in this type of vessel.

The *Henley* was built by the Fore River Shipbuilding Company, Quincy, Mass., and completed in the fall of 1912. The main machinery consisted of two direct connected turbines with two compound reciprocating cruising engines which were connected to the main turbine shafts by means of jaw clutches. The machinery to be supplied by the Westinghouse Machine Company will consist of two geared turbine units of the impulse reaction type, with Kingsbury thrust bearings and two geared cruising units. The new machinery will be installed in the same engine room space and will be connected with the existing propeller shafting and drive the propellers at the same speed as formerly. The two cruising turbines will each have a capacity sufficient to drive the ship at a speed of 15 knots. They will be connected to the main turbines by clutches and will be used only up to a speed of 15 knots. After this speed has been attained, they will be disconnected and the main turbines alone used. The turbine speed of 3,000 revolutions per minute will be reduced by the reduction

gears down to 640 revolutions per minute for the propeller shafting.

The *Mayrant* was built by the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., and delivered to the government in 1911. The propelling machinery consisted of two direct connected turbines without cruising engines. The turbines were designed to develop 13,000 shaft horsepower at a speed of 650 revolutions per minute with a steam pressure of 250 pounds gage. The new machinery for this vessel will be essentially the same as that for the *Henley*. The main turbines, however, will each have a capacity of 7,000 shaft horsepower at a speed of the propeller shafting of 629 revolutions per minute. The speed of the turbines will be 3,000 revolutions per minute.

Fuel Values of Alaska Coal for Marine Service

BY L. R. W. ALLISON

An important series of tests of Alaska coal, mined at Matanuska, has recently been made by the United States Navy Department, aboard the cruiser *Maryland*. Advance data giving the results of these tests are particularly interesting in showing the efficient fuel value of coal from this section, which with its vast deposits is destined to be a primary source of future supply for high grade anthracite coal.

The navy tests were conducted under four different conditions of operation, as follows: (1) port test, seven days' duration; (2) four-hour, forced draft, 20-knot test; (3) twenty-four hour, 15-knot test, and (4) 10-knot test;

The accompanying summary of the results of these tests is based upon a comparison with coal from the Pocahontas fields of West Virginia, a source of supply which is extensively used for Government service. This coal rates:

	Percent
Volatile matter	17.0
Fixed carbon	76.5
Ash	6.5
	100.0

Sulphur, 0.65 percent.
Moisture (coal as received), 2.5 percent.
Heat value, 14,700 B. T. U. (8,170 calories).

The heat value of coal from this field is found to vary from 15,000 B. T. U. (8,335 calories) to 14,500 B. T. U. (8,060 calories), with an ash content from 4.5 to 8 percent, respectively.

With coal from the Alaska field it is found that slight foreign matter exists, with no evidence of gas being given off during the tests. The coal is particularly friable, the lumps readily crumbling and pulverizing, while the slack has a tendency to burn better than the lump. A digest of the different tests follows:

Port Test—Seven days:

One boiler in service; all coal, ash and clinker were weighed. Run of mine coal employed for five days, slack one day and lump coal one day; forced draft necessary on two days.

Coal burned freely; firing was very good, analysis of flue gases showed rarely below 9 percent CO_2. Fire 6 to 8 inches thick carried during most of the period, occasionally slightly heavier. Draft was good, coal burning with bright yellow flame.

There was little clinker, but ash several percent higher than with Pocahontas coal; ash fused into clinker on the grate bars, generally about 2 inches thick, medium weight and porous, slightly touch and hard while hot, friable when cold. Clinker carried a little ash mixed throughout the mass, and adhered a little to the bridge wall, but not seriously.

Coal coked nicely, coke being friable and easily worked. Soot deposit about 25 percent greater than Pocahontas coal and slightly different, the granules appearing as minute fused grains. The load carried during the period of test would have ordinarily required two boilers using Pocahontas coal.

Four-Hour.—Forced draft, 20-knot:

Fires thin and burned brightly; firing easy, due to ready breaking up of coke. Dampers partly closed; furnaces formed one mass of yellowish flame. No excessive mass of ash formed.

Twenty-Four Hour.—Fifteen-knot:

Inaugurated with a battery of twelve boilers, but four later cut out to gain the highest efficiency. Fires carried from 6 to 8 inches thick; always glowing, ashpans bright; furnaces formed one mass of yellowish flame. Coal burned with great care, formed an easily worked coke, no excessive amount of ash or clinker.

Clinker friable when cold. Fires noticeably hot; coal burned like pine knots; in general, seemed easier to handle than Pocahontas coal. Analysis of flue gases showed generally high CO_2, over 9 percent. Total soot deposit about 10 percent more than generally made by Pocahontas coal.

Ten-Knot.—Inaugurated with a battery of six boilers, but two later cut out to give the greatest efficiency. Power afforded more than necessary, at times four evaporators being in use. Fires easily worked; coke easily broken; fires carried from 6 to 8 inches thick, occasionally slightly heavier, bright and level; clinker not very hard. Analysis of flue gases showed generally high CO_2.

The Economics of a Steamship Line

BY E. N. PERCY

This article, one of a series dealing with analytical methods applied to marine enginering, will take up the subject of economics under the following headings:

- Investment
  - Hulls
  - Machinery
  - Gear
  - Shore Plant
  - Interest
- Depreciation
  - Hulls
  - Boilers
  - Machinery
  - Gear
  - Repairs
- Hazard
  - Loss and Damage
  - Insurance
  - Responsibility
  - Safety Devices
- Earning Capacity
  - General Shipping
    - Freight
      - Cost
      - Classification
      - Rates
    - Passengers
      - Cost
      - Classification
      - Service
      - Rates
  - Specific Shipping
    - Colliers
    - Tankers
    - Ore Carriers
    - Grain Carriers
    - Lumber Carriers
    - Refrigerator
    - High Speed Pass.
- Obtaining Business
  - Estimating
  - Chartering
  - Salesmanship
  - Advertising
  - Service

Any given line of steamships will consist, as a rule, of a variety of designs, of different ages and different stages of depreciation. To arrive at the investment in a given ship, as a unit of an operating line, the following factors must be considered:

Original outlay for hull.

Original outlay for machinery, gear and furnishings.

Subsequent outlay for new machinery, etc.

Proportionate part of investment in shore plant for maintenance.

Balanced against these must be:
Depreciation charged off.
Salvage of machinery and gear removed.
Proportionate part of salvage from shore plant.

Often a new hull will have old machinery or an old hull new machinery. The same applies to gear, etc. Sometimes a steel ship will have extra wooden cabins added, which depreciate more rapidly than the rest of the ship but greatly increase the earning capacity. All such changes should be carried on special accounts, so that the value of that part of the investment may be arrived at. It is an unfortunate fact that ships can be built abroad much more cheaply than in America with proportionately less investment. Our laws are such that ships for interdomestic ports are necessarily constructed at home; but the economic laws of trade are such that our export trade will always be carried in foreign bottoms, financed in many cases in America, for American trade. It is not possible to combat these natural trade laws, except by creating artificial conditions that are necessarily short lived. Capital will not venture into American bottoms as an investment so long as foreign countries can build and operate ships more cheaply than we can, except in those cases where the ships are built to serve a particular industry. These conditions must be recognized as a basis of all marine investment. We can create and maintain artificial conditions at home by tariff, subsidies, etc., which are merely means of distributing over the population at large burdens which are normally carried by the shipper. So long as the people enjoy a compensating industrial activity this can be done, but the history of subsidies has been a gradual relapse to the normal condition, since natural laws will balance. For instance, the building up of the German and English merchant marines was a secondary result of the fact that these countries could produce their goods and build their steamships more cheaply than the rest of the world. These matters are mentioned merely because they affect investment, and are, in fact, vital to investment.

The fact that various parts of a ship depreciate at different rates is sufficient indication that they should be carried on separate accounts and be charged off at different rates, as any part of a ship may be renewed, or may even be transferred to another hull. All repairs and maintenance are charged off to depreciation. The operation account should be charged with material consumed only, since any repairs or maintenance are due to depreciation even if caused by operation. In the event that repairs eventually exceed the original cost of the part repaired, they should then be credited to investment. When this investment rises to a point that the ship is not paying proper dividends on the money invested, the ship must be scrapped or rebuilt. A ship, like any other structural property, is governed by the law of diminishing returns. These returns can be increased from time to time by repairs, rebuilding, etc., but there finally comes a time when the returns are so diminished and the cost of further repairs so high that it is cheaper to scrap the ship and realize such salvage as is possible from the hull and machinery and gear.

An important source of expense are the hazard accounts which include loss and damage from any cause whatever, insurance, investment in safety devices (more correctly, *interest* on such investment), and amount of responsibility or hazard incurred. These risks are largely covered by the law, but much leeway is left for companies to reduce their individual risks of fire, wreck, loss of life, loss of cargo, damage, etc. War risks should be carried in this account and a minor damage account for small collisions, hospital arrangements for employees, etc.

The earning capacity of a boat may be considered by dividing shipping into two groups, viz., those doing general shipping and those working for a specifice industry, and often especially constructed for that industry. The first class consists of freight and passenger ships, usually combinations of both. Freight rates are so thoroughly standardized now by agreements, commerce commissions, etc., that the cost of operation hardly constitutes a basis, especially as the export rates are largely set by foreign lines with whom we cannot compete. It should be more generally realized that a large proportion of the world's ships are owned by American capital, although flying foreign flags and running abroad. For instance, we note the Pacific Mail, Toyo Kisen Kaisha, International Atlantic Steamship Company and others.

The classification of passengers is also highly standardized, and the fares which they pay. It is a simple question of efficiency, as competition has reduced the passenger business to a question of cost versus service rendered. Things are so standardized that a passenger pays for each thing wanted, even to having a café aboard ship. All of this is based on an accurate knowledge of costs.

Specific carriers, such as colliers, tankers, ore carriers, grain carriers, lumbers carriers, refrigerator ships, high-speed passenger ships, ferryboats, and others, are built for one purpose only and can be made to operate with great efficiency because all parts can be proportioned to the one duty, men trained to this duty, and their operation reduced to a routine. Such craft are operated, usually, in connection with some industry and are entirely subordinated to the requirements of the industry. Such boats can attain greater economy than any other type of steamer, but economy is usually secondary to the requirements of the industry, which, primarily, are regular and reliable service, regardless of any other consideration, because they have large interests absolutely staked upon the regular and timely arrival of these boats.

No small part of any steamship line is that department which obtains business for them. It is salesmanship pure and simple. Pioneer boats on a new route are usually small, under charter, and run irregularly. It depends upon the sales force to develop such business into a regular route. A transportation salesman covers a broader field than any other type. He must call on all industries and bring firms in widely different territories together for mutual benefit. He must be in touch with a hundred industries. He must have general knowledge of economic conditions throughout the countries which his line connects, and successful salesmen of this type do have this knowledge in actual practice.

In making estimates for cargo or freight it is customary to have estimate blanks mentioning the more usual sources of expense, such as insurance, cost, harbor charges, pilotage, customs charges, wharfage, cartage, etc., etc. In making such an estimate, every link in the chain must be complete from the shipper to the consignee. Some shippers ship from "ship's slings to ship's slings," others from wharf to wharf, etc., according to agreement and conditions.

The design of the ships, their operation, the organization of the service, proper advertising, a knowledge of the territory served, and the co-ordination of all this effort requires executive work of the highest order.

In rehabilitating the American merchant marine no one thing is needed more than to present marine work and steamship service to young men as a career, where they can serve with honor to the highest positions, rather than a trade, in which they are knocked from pillar to post with no definite future or permanency of position.

Gain of Cargo Capacity in Motor Ship of About 3,000 Tons Deadweight Capacity

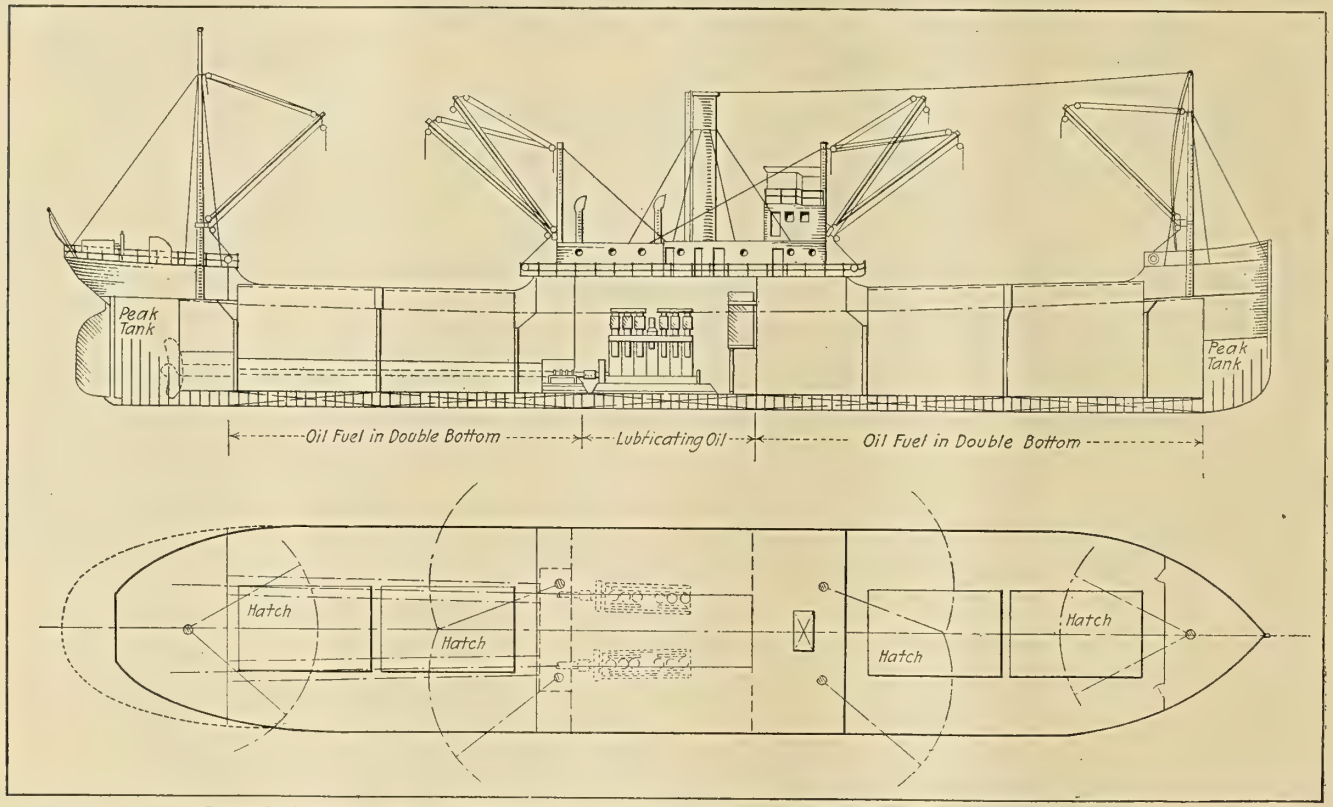
BY R. W. CROWLEY

During the period when high freight rates and full cargoes have been prevailing the shipowners have been so busily and persistently concerned with ways and means of utilizing their immediately available resources to the greatest profit that they have had no opportunity to study the continuing and increasing successes of the full-powered motor ships that are issuing steadily from the Danish and Dutch shipyards. Also the craze for installing auxiliary propelling power in wooden vessels has diverted attention from the full measure of development to a half measure of development, in just such a manner as happened during the era of introduction of steam into the shipping world.

Yet while steamers have been earning much money the motor ships have been earning even more, and this has been happening even where American owners could have noticed it had they so cared. Danish motor ships have been carrying case oil from the United States to China, and, though the figures have varied for each vessel, the general advantage is indicated by the statement that in a particular instance, for example, the motor ship carried about 40,000 cases more than a steamer of the same length could have carried, and that meant a clear extra profit of about $70,000 (£14,400) on a passage lasting about 35 days.

That the benefits of the motor ship are not, however, restricted to foreign owners, but can be seized by American owners who are operating vessels in nearby waters, is becoming recognized by the more discriminating firms, and inquiries to this end are being made in the few quarters where trutsworthy oil engines of the requisite power can be obtained.

How well a motor ship would serve in the New York-West Indies trade, for instance, is demonstrated by the comparison given in the following between a motor vessel and a steamer, both of about 3,000 tons deadweight capacity. These figures were prepared for an owner who was considering a new vessel for the log trade, and it was finally on account of the special conditions of this trade that the order for the motor ship was not placed. Upon occasion logs would have to be loaded in an open roadstead, and the danger of these fouling the propellers was adjudged to be of such weight that a twin screw installation could not be accepted, and since the engine builders were not ready to quote on a single engine of 1,000 brake horsepower the project of this motor vessel had perforce to be abandoned. In the figures, however, other shipowners may perhaps find inspiration.



General Arrangement of Twin-Screw Motor Ship of About 3,000 Tons Deadweight Capacity

This vessel measures 251 feet in length between perpendiculars (261 feet length over all), has a molded breadth of 43 feet 6 inches and a mean depth of 20 feet, the load draft being 17 feet 6 inches. To give the ship a speed of 10 knots the power required will be: Steam, 1,200 indicated horsepower; four-cycle Diesel type, 1,000 brake horsepower.

This machinery will consist of a triple expansion steam engine or of twin screw Craig Diesel type engines, and, inclusive of boilers, shafting, propellers, engine room auxiliaries, etc., as may be required in each instance, will weigh complete: Steam, 210 tons; four-cycle Diesel type, 130 tons.

On a basis of bunker capacity for 26 days steaming at five-sixths full power, and calculating 18 tons of coal per diem for the steam engine, while the Diesel type engines will consume only four tons per diem, the weight of fuel carried will be respectively: Steam, 469 tons coal; four-cycle Diesel type, 104 tons fuel oil.

Additonally there is to be taken into account the fresh water needed for the boilers, this in the case of the motor ship being for the donkey boiler. In the respective cases

these figures will amount to: Steam, 75 tons water; four-cycle Diesel type, 25 tons water.

Although the machinery of the motor ship will weigh 80 tons less than that of the steamer, the assumption will be made that perhaps only 50 tons of this saving can be utilized to increase the deadweight capacity of the ship. Thus the respective cargo capacities will be: Steamer, 3,000 tons deadweight capacity; motor ship, 3,050 tons deadweight capacity.

For the stores a weight of 12 tons may be accepted, this being the same in both classes of vessel.

With these premises one can calculate the respective capacities of the two ships on an outward passage with bunkers full and fresh water tanks replenished.

Steamer		Motor Ship
3,000 tons	Deadweight capacity	3,050 tons
469 tons	Coal—Bunkers—Oil	104 tons
75 tons	Fresh water	25 tons
12 tons	Stores	12 tons
556 tons		141 tons
2,444 tons	Cargo capacity outward	2,909 tons

With the assumption that the outward passage is made in 10 days, the steamer's cargo capacity will be increased to the extent of 180 tons, representing the coal that has been burned, but the motor ship's cargo capacity will be increased only by 40 tons, the consumption of fuel with Diesel engines being so much smaller in comparison. Thus on the homeward passage the figures will be:

Steamer		Motor Ship
2,624 tons	Cargo capacity homeward	2,949 tons

Thus the motor ship enables 465 *tons* extra cargo to be carried on the outward passage and 325 *tons* extra on the homeward run, an aggregate additional *gain of* 790 *tons earning freight* on the round voyage.

In the steamer of the dimensions here accepted the cubic capacity is 133,000 cubic feet at 42 cubic feet per ton. In the motor ship six extra frame spaces are given to the hold by the reduction of machinery space (the forward bulkhead of the engine room would actually be two frame spaces further aft than is indicated on the blueprint, where four frame spaces have already been saved from the corresponding engine room of the steamer). These six frame spaces increase the hold capacity by 8,256 cubic feet. Furthermore, in the motor ship the space occupied by the bridge bunkers of the steamer is available for cargo, this representing 334 tons at 42 cubic feet per ton, equaling 14,000 cubic feet. No benefit accrues to the motor ship through the lapse of side bunkers in the engine room, the space so yielded being required for the auxiliary engine sets. On the debit side there is a loss of about 1,000 cubic feet, due to the twin shaft tunnels of the motor ship in comparison with the single tunnel of the steamer, and about the same figure (say 1,256 cubic feet) is to be deducted for the donkey boiler space. Thus the cubic capacities of the two vessels are:

Steamer		Motor Ship
133,000 cubic feet	Cubic capacity	153,000 cubic feet

Hence the motor ship affords about 15 percent greater cubic capacity and about 15 percent greater cargo-ton capacity than the steamer. That is its greater profit.

When this percentage is translated into dollars its significance appears perhaps more pronounced. For instance, assuming a freight of coal to Havana at $3.50 per ton and a sugar cargo homeward at 30 cents per 100 pounds, then the freight earnings would be:

Steamer		Motor Ship
2,444 tons at $3.50		2,909 tons at $3.50
= $8,554	Earnings outward	= $10,185
2,624 tons at 30 cents per 100 lbs.		2,949 tons at 30 cents per 100 lbs.
= $17,633	Earnings homeward	= $19,817
$26,187 (£5,375)	Round-voyage earnings	$30,002 (£6,160)

With eight voyages per year in this trade the difference in the earnings of the two types of vessel would be 8 × $3,815 = $30,520 (£6,275) per annum in favor of the motor ship, a sum which represents extra profit and is not subject to any deductions. The vessel would probably be making other voyages in the West Indies, but since the proportion between the motor ship and the steamer freight earnings would remain substantially the same on those other voyages, the assumption of the eight round voyages between New York and Havana, which is adopted here for simplicity's sake, is reasonable and valid. The figures can be calculated for other cases if so desired, and will be found to leave the final proportions practically unaltered.

There are also other savings. Taking bunker coal today at $3.50 per ton New York, and assuming that fuel oil be taken aboard at Jacksonville, Fla., where it can be purchased at $1.50 per barrel, which is cheaper than buying in New York, even though port charges of $250 would be incurred at Jacksonville, the respective fuel costs, assuming 20 days' steaming on the round voyage, will be:

Steamer, 18 tons coal per diem for 20 days, at $3.50 per ton, $1,260; motor ship, 4 tons oil per diem for 20 days, at $1.50 per barrel, equals $720, plus port charges, $250, at Jacksonville, Fla., equals $970.

With a fuel saving thus of $290 (£59.5) per voyage to the credit of the motor ship, the annual saving on the assumption of eight voyages per year will be 8 times $290, equals $2,320 (£476).

In respect of engine room crew there will be a saving both in wages and in the food bill, the motor ship being able to dispense with the "black squad." This saving will be greater on a ship under the American flag, but it is considerable also under a foreign flag, and for the purpose of this comparison it will be supposed that the vessel will fly foreign colors. Then the manning of the engine room will be, respectively:

STEAMER	MOTOR SHIP
Chief engineer.	Chief engineer.
3 assistants.	3 assistants.
3 oilers.	3 oilers
6 firemen and messboy.	
1 donkeyman	1 donkeyman

This means a saving to the motor ship of six firemen at $40 per month, equaling $1,440 (£296) per annum, plus the wages of the messboy, making a total of $1,740 (£358). The subsistence allowance, being 50 cents per man per day, amounts to $1,279 (£262) per annum. The total saving under this head will be $3,018 (£620) per annum.

Grouping these items, it will be seen that the extra profits accruing to the motor ship through increased freight earnings by the larger cargo capacity are $35,858 (£7,380), while the savings effected amount to $5,338 (£1,100), a total difference of about $41,000 (£8,480) in favor of the motor ship.

If the steamer cost be reckoned at about $350,000 (£71,800) at the prices prevailing when these estimates were prepared, and the motor ship cost be accepted at almost $400,000 (£82,000), it will be observed that the extra profits from the motor ship are practically sufficient to write off in one year its higher capital cost, amounting as they do to more than 10 percent of the motor ship cost.

This comparison is one of the least favorable to the motor ship that can be made, inasmuch as it deals with fuel conditions that show practically no favor to the motor vessel, and the extra profits arise almost entirely from the increased cargo capacity.

A NEW ORGANIZATION, the Marine Engineers' Beneficial Association, Ocean, No. 99, has established headquarters at 11 Broadway, New York.

BUILDING WOODEN VESSELS ON THE PACIFIC COAST



Fig. 1.—Five-Masted Schooner in Frame



Fig. 2.—Shipbuilding Timber



Fig. 3.—Products of the Pacific Coast Yards

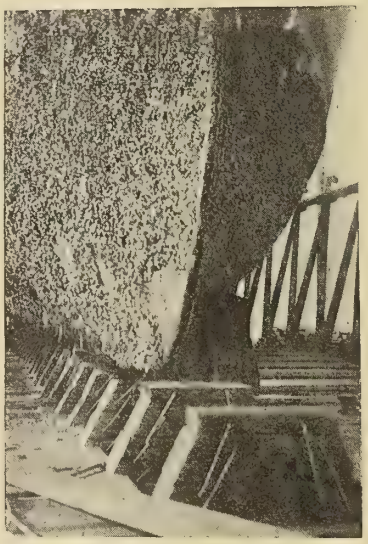


Fig. 4.—Work for the Pacific Coast Dry Docks



Fig. 5.—Making Ship's Spars



Wooden Shipbuilding on the Pacific Coast

Simultaneous Development of the Lumber and Wooden Shipbuilding Industries on the Western Coast—Decline and Revival of Wooden Shipbuilding—Growing Popularity of Auxiliary Sailing Vessels

TO give an intelligent description of the growth and development of the wooden shipbuilding industry on the Pacific coast it is necessary to outline briefly the growth and development of the lumber industry on the western coast, as the two industries were interdependent and were developed simultaneously.

The Pacific coast is the home of the largest belt of timber of commercial value in the world. The lumber belt extends continuously for over one thousand miles along the coast between latitudes 40 to 58 north, and in width approximately two hundred miles inland from the coast. For the past thirty years this timber has been extensively manufactured and shipped to all parts of the world, the most extensive market being California and rail shipments east. The principal foreign markets are New Zealand and Australia, the west coast of South America, South Africa and the Hawaiian Islands, and since the opening of the Panama Canal a large business is being built up with the east coast of South America.

In density the growth of timber on this area is very uniform, and many sections of this land will yield as high as 24,000,000 feet of merchantable lumber to the acre, the average being 6,000,000 to 8,000,000 feet to the acre. To market this product many ships are required, and as a consequence many wooden ships have been built. The timber of commercial value which this area produces consists of eight varieties, which vary according to the zone in which it is grown. In the southern latitudes the redwood, sugar pine and Port Orford cedar predominate. The redwood is not suited for shipbuilding purposes, as it splits too easily, but is used extensively for building purposes. The sugar pine is the best known variety of lumber for interior finishing, cabin work, etc., and is extensively used for patternmaking. The Port Orford cedar is considered the highest grade of lumber in the list of woods used for shipbuilding purposes, but owing to its limited supply it is no longer used in large vessels, but is largely used for yacht work, small boats and the like. Its merit lies in its extreme lightness, strength and lasting quality, which are beyond that of any wood known.

Immediately north of this belt, extending throughout Oregon, Washington and the British Columbia coast, the Oregon pine or Douglas fir predominates. This timber is the chief commercial timber of the coast, and ranks high in grade for strength, durability and the ability to secure large and long length timbers from the trees. It is an ideal timber for shipbuilding purposes, being used in lengths up to 130 feet. Keel timbers are secured in lengths of 100 to 120 feet, and in sizes of 18 inches by 30 inches to 32 inches. The lasting quality of this lumber is not to be compared with the Port Orford cedar, but a vessel built of it, with ordinary care, is good for a life of twenty-five to thirty years.

The other commercial varieties of timber grown here include the red cedar so extensively used for shingles and interior finishing, and hemlock used for building purposes and interior finish. Neither of these varieties, however, is used in shipbuilding. In the northern portion of this timber belt the spruce predominates and is used to some extent for sheathing bottoms of ships, planking for small boats, etc., but is not used in heavy ship construction, as it decays too readily when confined to permit of its use for this purpose.

In the northern portion of this belt is also found the eighth variety of wood, which is gradually becoming more extensively used for shipbuilding purposes as its value becomes more generally known. This wood is the Alaska cedar. Its merit lies in its strength, lightness and lasting quality. Ship's frames built of this material are good for one hundred years without decay, and examples can be found of vessels built of this wood by the Russian Government when Alaska belonged to that nation that are still in good condition after having been in use nearly one hundred years. This timber is somewhat scrubby in growth, and is best suited for ships' frames and timbers, as the long lengths desired in the ceiling and planking of wooden ships cannot be obtained from it. A combination of either the Port Orford cedar or Alaska cedar for frames, deadwoods, etc., in a wooden ship, with the fir for long timbers and planking, gives the best possible results to be obtained in wooden shipbuilding, and a vessel of this character will outlast the oak and pitch pine construction that has long been considered the acme of perfection in the building of wooden ships on the east coast.

In the early development of the lumber industry on the Pacific coast the first market for these forest products was San Francisco and the lower California coast, and occasionally one of the old-time square rig ships plying

between San Francisco and New York or Europe would be sent north to Puget Sound, and would, by crude methods, cut and roll into the waters of the Sound from the heavily wooded shores such logs as were most easily obtained. These were then floated alongside the ship and hoisted aboard by hand power, as at that time steam was not used on the sailing ship. These logs were then carried to San Francisco and there sawn into lumber for building purposes, as the city was then beginning to build up and develop as a result of the gold discoveries in California. Later, sawmills were established on Puget Sound, Gray's Harbor, the Columbia River, Coos Bay and other points along the coast, and the logs cut into lumber at these mills.

Single Deck Lumber Schooner

In order to transport this lumber to market it became necessary to build up a fleet of sailing vessels for the purpose. It was then found that the double deck vessel that had commonly been used in the deep sea traffic was unsuited for this lumber trade, owing to the difficulty in handling the long timbers in their holds. To obviate this difficulty the single deck vessel was developed. This at first consisted of small two-masted schooners capable of carrying 250,000 to 300,000 and 400,000 feet of lumber. These vessels were of light draft and given a broad beam, so as to carry deck loads, and in loading about two-fifths of their cargoes were stowed under the decks and three-fifths on deck. As the demands for lumber increased the size of these vessels was gradually increased, leading to the construction of four and five masted schooners and barkentines. These vessels, in size, are considered about the limit for building single deck vessels of wood. The capacity of these vessels now averages approximately 1,500,000 feet, and their trade has been extended from the coast business to Australia, South Africa and the West Coast. For Australian trade these ships usually carry return cargoes of coal from New Zealand and Australia to the West Coast, Hawaiian Islands or San Francisco.

With the growth and development of these ships the firm of Hall Brothers and their successors have been closely identified. The firm was organized at San Francisco, Cal., in 1872, by the late Winslow G. Hall, Henry K. Hall and Isaac Hall, and their shipyard was established at Port Ludlow, Wash. In 1902 the yard was moved to its present location at Winslow, Wash.

Prior to removing to San Francisco the Hall brothers had been engaged in the shipbuilding industry in Boston, Mass., and Winslow G. Hall, the designer for the firm, had had extensive experience there in the construction of the fishing vessels then so extensively used on the east coast and known as the Gloucester type of fisherman. In designing the lumber schooners for the Pacific coast trade Mr. Hall embodied in them the graceful lines, clipper bow and elliptical stern that have been so much admired in that type of vessel. As the size of these lumber vessels was gradually increased to meet the demands, the same model and graceful lines were continued throughout the entire fleet of sailing ships built by this firm.

This firm has built a larger number of wooden ships by far than any other one firm on the coast. Other firms have established shipyards at various points on the coast for building wooden ships, chief of which have been the Bendixsen Shipbuilding Company, at Eureka, Cal; Kruse & Banks shipyard, at Marshfield, Ore.; the Lindstrom Shipbuilding Company, at Hoquiam, Gray's Harbor, Wash., and the Matthews Shipyard, at Aberdeen, Wash. Hiram Doncaster, an old-time east coast shipbuilder, also established a yard on Puget Sound and built several ships at Seabeck, one of the old-time lumber ports of the Sound —since abandoned. He also built several vessels at Port Ludlow after the present mill plant was established there. Thomas Peterson, one of the old-time shipbuilders from the east coast, also established a yard and built several vessels at Port Madison when that point was one of the principal lumber ports of the Sound. The Seabeck and Port Madison mills have long since been discontinued, and the yards established there discontinued business several years ago. Crawford & Reed established a yard at



Fig. 6.—Four-Masted Schooner *Balboa*, Built by Hall Bros. in 1901



Fig. 7.—Typical Wooden Schooner (the *Nokomis*), Built by Hall Bros.

Tacoma, Wash., but have confined themselves to the building of wooden steamers, principally for the fishing trade. Charles White established a yard at Everett, Wash., and built several vessels there up to the time of his death in 1904. Since then the yard has been discontinued. Ed. Heath established a yard at Tacoma about 1902 and built several seagoing vessels, including the well-known Alaska excursion steamer *Jefferson*. He has lately removed to Seattle and is now engaged in building there. The Simpson Lumber Company, of Willapa Harbor, has built a number of vessels, principally for their own use in their extensive lumber business. This yard has discontinued building since Mr. Simpson's death several years ago. Several vessels have also been built at San Francisco and Oakland, Cal., by Middlemast & Boole, Mr. Boole individually and by Stone's Shipyard.

Collectively these firms have built wooden ships in number equal to those built by the Hall Bros. Company, extending over an equal period of time.

This comprises the extent of the development in wooden shipbuilding to date on the Pacific coast.

Decline of Wooden Shipbuilding

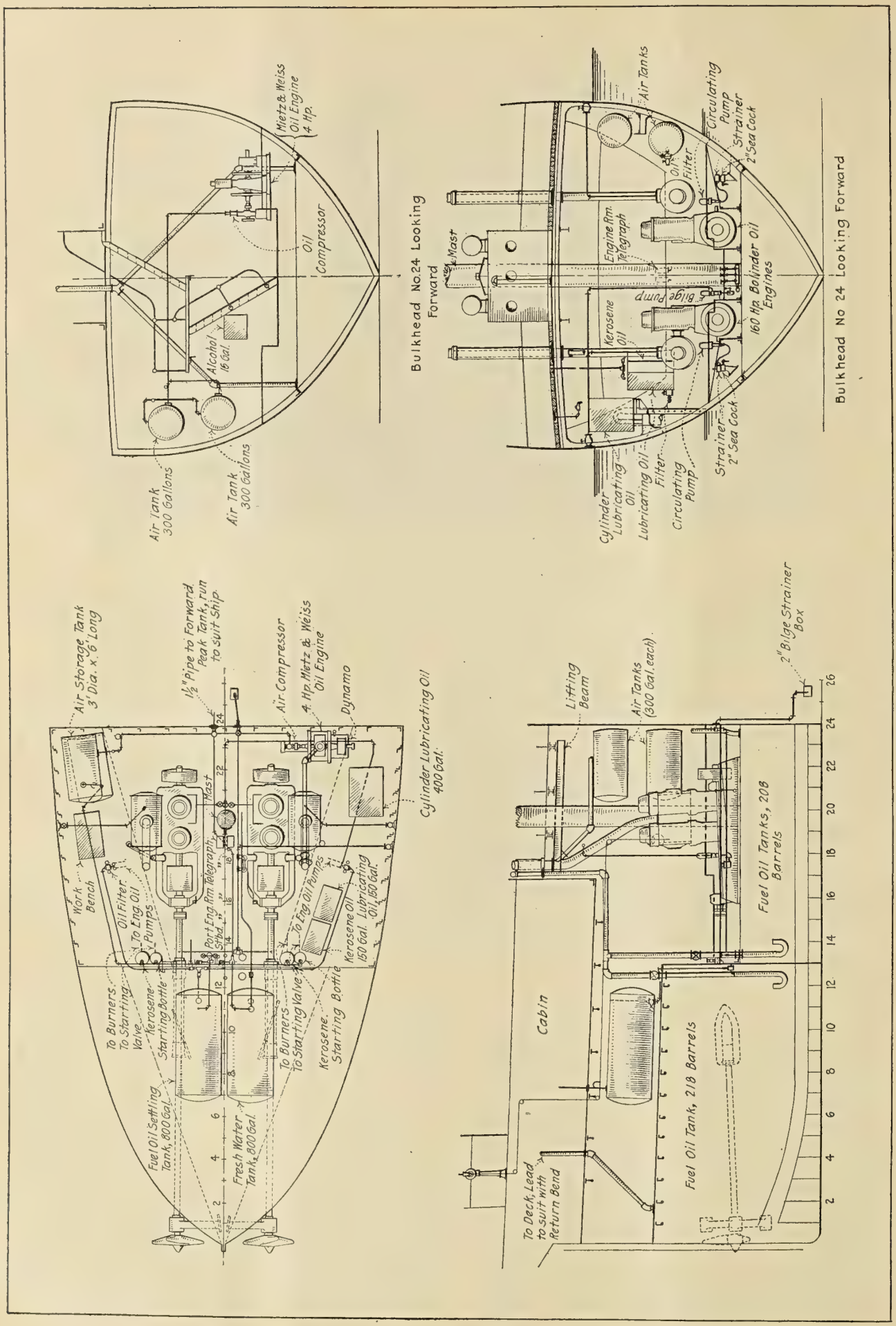
Since the Hall Bros.' plant was established at Winslow in 1902 no sailing vessels for the lumber trade have been built on the Pacific coast, and the business for ships of this class has gradually declined, owing to the large number of tramp steamers coming to the coast that could carry lumber to foreign ports at a rate below what it would pay to carry it on the sailing vessel, particularly the small type, so that none of the wooden ships now remains in the lumber trade except those of the larger capacity. The smaller vessels have gradually disappeared by loss or through being diverted to other lines of trade, such as fishing and trade on the Mexican coast and the coast of Peru, where vessels of this character are still found profitable to operate.

Replacing the wooden sailing vessel for the coast lumber trade, the type of vessel known as the steam schooner has appeared, and in the past twelve years a large number of these vessels have been built.

Power Craft Predominate

Except for the temporary boom due to the European war, it is believed that the era for the construction of wooden sailing ships on the Pacific coast has practically passed, and that the shipbuilding firms who desire to continue in the shipbuilding line will ultimately be compelled to take up steel construction or go out of business, as the demand now seems to be for steel vessels of large tonnage—too large, in fact, to be built of wood in a practicable manner. Vessels 250 feet in length are considered about the maximum size for a wooden ship with single deck, as a larger vessel built of wood is apt to show structural weakness due to its own weight, and the difficulty encountered in securely fastening the structural members together to maintain the excessive strength necessary in that size vessel. Of course small wooden vessels, such as are used by halibut fishermen and small trading schooners for Alaska coast and Arctic trade, will still be built, but these vessels could hardly be classed as ships.

Gasoline (petrol) power has become so commonly used of late that practically all of the small vessels referred to are now fitted with auxiliary gasoline (petrol) engine power. At present there is being built on the Pacific coast one auxiliary powered wooden sailing vessel intended to carry a lumber cargo of 2,000,000 feet board measure. This vessel is being built for the McCormick Lumber Company, of San Francisco, by the St. Helens Shipbuilding Company, at St. Helens, Ore. Her length is 286 feet over all and the beam 42 feet. One other wooden auxiliary powered sailing vessel has been contracted for by the Matthews Shipbuilding Company, of Hoquiam, Wash., and will be of about 1,500,000 board feet lumber capacity. This vessel, if properly designed, should be a practicable ship. The Matthews Shipbuilding Company also had

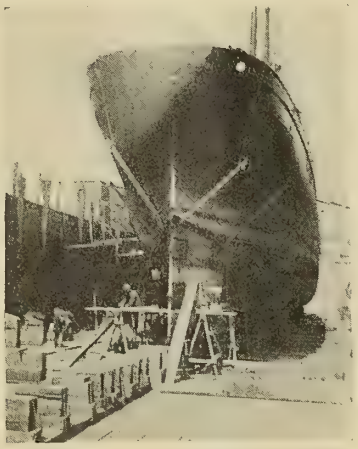


Plans of Machinery Space in Auxiliary Schooner *Annie Johnson*

under construction a wooden steam schooner intended for the coast lumber trade. Numerous inquiries are of late being made for auxiliary powered sailing vessels built of wood, but aside from the two vessels mentioned none has developed to the point where their construction is assured.

As indicating the present tendency in the development and use of auxiliary power in the sailing vessel, it may be stated that in all of these inquiries the proposition of installing either gas engines or crude oil engines is considered, so that it is very probable the sailing vessel of the future will be incomplete without the installation of this equipment. It is calculated that by the installation of small power of this character the vessel would often be enabled to move out of the calms that they frequently encounter in off-shore voyages, and thus be able to make much better despatch in their voyage as a whole.

The Oregon pine or Douglas fir timber as grown in the Pacific coast district provides the best spars for ships that are grown in any part of the world. These timbers are selected standing in the woods where grown. The ordinary schooner mast requires a log approximately 36 inches in diameter at the butt and 24 inches to 26 inches in diameter at the top end, and from 100 to 110 feet in length. What is commonly called the bald-headed schooner, as occasionally rigged out on the Pacific coast, requires a spar of the above size ranging from 125 to 130 feet in length. Such spars are readily secured in the forests from one-length timber. These spars, however, are gradually becoming more expensive, as since the timber near the shore is being cut away they have to be brought to the Sound by rail over crooked roadbeds where frequent wrecks in handling timbers of this length occur. It requires at least three cars to carry a load consisting of three of these spars, and in the extreme curves on the roadbeds these loads often overhang the track so far that they tip the cars off the track. For this reason the price of these spars has advanced very materially in the past few years, so that at present one of these spars installed complete in one of the lumber schooners, including all rigging work in connection with the installation, costs from $400 to $450 (83/6/8 to 93/15/0).



Auxiliary Schooner Annie Johnson

Iron Barque Built in 1872—First Converted Into a Schooner and Finally Equipped With Heavy Oil Auxiliary Engines

BY EDWARD O. PERKINS

The barque *Annie Johnson,* built in 1872 and converted into a schooner in 1880, was fitted in April at the Union Iron Works, San Francisco, with two 160 horsepower Bolinder engines. The ship is built of iron and is in remarkably good condition. The principal dimensons are as follows, Length overall, 212 feet 1 inch; length between perpendiculars, 203 feet; beam, extreme, 34 feet 1 inch; beam, molded, 34 feet; depth, molded, 22 feet 3 inches.

A deep tank was built in the extreme after end from the stern post to frame 13, and another tank 7 feet deep from frame 13 to frame 24. The top of the 7-foot tank forms the floor for the engine girders, and is amply braced and stiffened with 8-inch by 3-inch channel beams clipped to the center keelson and with intercostals under each engine frame.

The mast, which formerly rested on the center keelson, was restepped onto the 7-foot tank top. The frames were cut in way of the tank tops, and bracketed with ½-inch brackets.

The capacity of the deep tank aft is 243 barrels and of the 7-foot tank 216 barrels, making the total fuel-carrying capacity 459 barrels of oil.

The propeller struts are of cast steel, fastened to the ship with tap bolts the heads of which were electrically welded. This was made necessary because of the extreme fineness of the vessel, which made it impossible to rivet through the shell at that point.

The auxiliary power is provided by two 160 horsepower crude oil marine type engines, built by J. & C. G. Bolinder, Stockholm, Sweden. Each engine has two cylinders, 16½-inch diameter by 18¾-inch stroke. The overall dimensions of the engines are: Length, 13 feet; height, 6 feet; width, 4 feet.

Each of these engines, complete, weighs 230 cwts. and develops 160 horsepower at 225 revolutions per minute.

The vessel is equipped with a 4 horsepower Mietz & Weiss oil engine, direct connected to an electric generator and an air compressor, built by the Herzog Electric & Engineering Company of San Francisco, Cal. A bilge pump and circulating pump are furnished by J. & C. G. Bolinder Company in connection with the main engines.

There are two three-bladed propellers, 6-foot diameter and 4-foot 1½-inch pitch. The expanded area of each propeller is 11.92 square feet, the projected area 10.95 square feet and the disk area 28.27 square feet.

Scientific Studies Applied to Riveting

Cost of Riveting in Ship Construction Analyzed—Importance of the Labor Problem—Methods of Reducing Costs

BY WILLIAM M. KENNEDY

Owing to the wonderful advances made in the fundamental principles of scientific management in the past few years, it will be interesting to note some of the accomplishments in different operations in a shipyard.

The following astonishing result obtained by Mr. Frank B. Gilbreth may be interesting to recall. Mr. Gilbreth by applying "motion study" to bricklaying, one of the oldest trades in existence, increased the daily output from 1,000 to 2,700 bricks. This largely increased output was not obtained by speeding up, but by careful scientific study which revealed the lost motions, thereby removing the obstacles to production which annoy and exhaust the workmen.

If such inefficiencies can be shown to exist in one of the oldest trades, what are the conditions of the later-day trades? I particularly refer to pneumatic and hydraulic riveting. Although many improvements have been made by structural workers and shipbuilders in this trade, the output at the point of the tool has not increased in proportion to the improvements in equipment of the standards established by the manufacturers of rivets.

Standards and Improvements Required of Material and Equipment

The manufacturers of rivets provide the following information in an effort to excel and meet the requirements demanded of their product. The chemical tests determine the quantities of phosphorus, manganese, sulphur, and carbon; the physical tests reveal the elastic limits, elongations, shearing strength, tensile strength, etc. The manufacturers of equipment are producing more efficient machines or improving present ones; better types of heating forges have been devised, among them being the rivet oil forge. Manufacturers of hydraulic riveting machines consider even the economical use of water by their machines—after the rivet is driven the water returns to the tank and is used again. High speed air hardening steel dies are being used successfully in hydraulic riveting machines. These dies drive from 40,000 to 50,000 rivets without redressing. It is only by constant study and tests, aided by staff specialists †, that these improvements are possible. Mr. Hamilton Church in "Production Factors" states, "If profit is to be made anywhere in manufacturing it must be made at the point where the tool touches the work."

By tests and analysis rivets are proven to meet all requirements; equipment is efficient and constantly improving, but the output—the key to economical shipbuilding and profits—is lacking. Output for riveting is at the same stage at present as bricklaying was before Mr. Gilbreth showed the doubters how it could be done.

Magnitude and Elelments of Riveting; Standard of the Minor Elements

When one realizes that riveting is the most costly single operation of the structural portion of shipbuilding, representing approximately 30 to 45 percent of the total cost of labor (according to the type of ship), it can be readily understood what a remunerative field is open to the attacks of scientific studies.

Cost of riveting is composed of the following:

(1) Direct labor (wages of productive labor only).

(2) Indirect expense (comprising interest, depreciation, maintenance, power, and a portion of supervision, organization, tool charge, oil, waste, etc.).

(3) Material (cost of rivets, which absorbs freight charges, handling, and a portion of stores charges).

Of these three elements*, the cost of the first is the greatest, being equal to or greater than the cost of the second and third. Yet laboratories are fitted out, chemists employed, expensive machines purchased for tests, staff specialists engaged, all in an effort to standardize and improve material and machines, the minor elements of riveting. All this has been proven to be economical and remunerative. Why, then, is labor, the most expensive element of riveting, allowed to drift along unstandardized?

Analyzing Operations; Chemical Test of Fuels; the Proper Forges

We can begin by taking the elements of each operation, comprising riveting, and arrive at some of the existing conditions that are in doubt, then by constantly seeking with an open mind a better method of performing every elementary operation by intensified observation, research, and study into domains largely unexplored, present methods can be improved until, behold! a "Gilbreth" to master the art of large output, with less effort, is found.

The question of the most suitable fuels, owing to their effects on the various ingredients contained in a rivet, should be determined by chemical tests. From information obtained by the tests, the most suitable and economical fuel for all conditions and localities could be determined.

Fuel decided by conditions will be discussed with forges.

The price of fuels varies considerably in different localities; therefore, where the tests show two or more fuels to be equally suitable for certain classes of work, the lowest priced can be purchased with a secure feeling of not having sacrificed efficiency for economy.

As the economical features of riveting are being discussed it will not be out of place when considering forges to consider the indirect expenses due to the uses of different types, as oil, air, and hand forges. Each type represents an investment, the former being the most expensive, and when considered as a "productive factor," † the hourly charges due to its use make this type adaptable only to work for which it is designed to be used, that is, in connection with machines that drive large quantities.

The portable air forge with its limited output and slightly lower charges is well suited to work where the demand for quantities is not great. Its advantage over the first type is slightly lower charges. If oil forges were

† This function is clearly defined by Mr. Harrington Emerson in "Efficiency as a Basis for Operation and Wages."

* Under the present cost accounting system or averaging methods, the cost of labor is much greater than the sum of indirect and material costs, by the production center method of assigning any expense that has a definite relation to a machine (a machine being a producing unit), quite different results would be obtained.

† See Mr. A. H. Church's "Productive Factors."

used when the second type will supply the demand, it is very apparent that the difference in hourly charges is wasted.

Considering interest, depreciation, and maintenance on forges, hose and connections for the first two types, also the cost of power and fuel, it can be readily seen how much higher the costs are over hand forges, and yet hand forges can be successfully used for certain classes of work. Hand forges can be shifted quicker and easier than other forges, so become indispensable for odd work; their idle time, while being wasted, is not so great. The saving to be gained by using the right forge in the right place, while small, will add to the economy of riveting. The aim should then be to use the forge carrying the lowest burden, or hourly charge, that can have a hot rivet always ready when wanted.

Method of Deciding on Right Machines

Of the several different kinds of riveting machines, which of the following is most economical and adaptable for your work—hydraulic machine, hydro-pneumatic machine, pneumatic lever machine, pneumatic toggle joint machine, pneumatic compression yoke riveter, pneumatic hammers or hand riveting?

The machines are made in any size, each designed for definite uses, each machine being best for only one certain class of work, as no machine can be adapted to all classes of work, and as it is the machine that gets the blame for failure, not the varied uses to which it has been put; thus by determining the right machine and using it only for its designed purpose, the expense of failure will be avoided. No one would expect a riveter to perform electrical and plumbing work equally as well as the work of his own vocation, so why expect the same of a machine?

Only by careful motion studies and expert cost accountants can the question of which is the best machine be answered. A motion study will reveal many things, among them being the right machine, the right man, the pounds pressure for the most economical work, pounds pressure for a pneumatic hammer requiring the very least effort on the part of operator to drive a rivet, effects on a workman when work is not ready (as bolted, reamed, stages ready, etc.), to what extent protection from the sun and blowers for closed compartments should be provided—taking into consideration that the machines carry an hourly burden, idle or in use. The above are a few of the many considerations affecting lower costs.

The cost accountant—so essential to management—should furnish the hourly burden on machines, and knowing the producing capacity, the matter of the right machine is solved.

With the many types of machines on the market and the manufacturer's willingness to experiment, no trouble will be experienced in getting the right tool. A pneumatic compression yoke riveter appears the logical machine for reducing costs. First, the number of rivets that can be driven with this type of machine is far in excess of the output with pneumatic hammers, the method by which most rivets are driven. Second, highly skilled labor is not required.

Efficient Methods

At the Pennsylvania Steel Company's works, Steelton, Pa., pneumatic yoke riveters handled by three-ton electric cranes are used. Very little bolting of the work is required. As the riveter seems to draw work up, no plate-closing device is attached to the machine. Work is laid horizontally on horses and 20 to 25 rivets are taken out of the fire at once and thrown on the girder. They are placed in holes, point down, one or more ahead of the machine at all times. Before this lot is used up, or the last ones get too cold to drive, fresh ones are ready. The furnaces are placed between the main crane runway, thereby occupying practically no floor space.

These furnaces resemble somewhat the usual blacksmith's furnace with a comparatively small chamber, they are fired with coal and have automatic stokers; about 80 rivets are placed in the fire at one time and taken out in quantities as heretofore described.

Uses of Compression Riveting Machines

Practically all structural work on the ground could be driven with this type riveter, except the center of large bulkheads.

As for the methods of holding machines, there are many light portable cranes adaptable for this work, which will allow riveting to be done at place of assembling as at present with pneumatic hammers. There is no reason why the work of yoke riveters should be confined to ground work, providing machines with sufficient reach and gap that are light enough for handling aboard ship are designed—even structural workers are using light yokes for field work, eliminating one man in the gang. The keel and center keelson could be lined and faired up, then driven with the yoke riveters. There need not be any unnecessary delay by this method, as no other work should be put down until the keel is absolutely faired and checked. Floors are driven on the ground, so after placing them and bolting to bottom plating, intercostal longitudinal clips to floor and inner bottom, also clips of floors to center keelson, can be driven, stringers, breast hooks, beam brackets, bilge keels, hatch and deck house coamings, waterway of top deck to shell, tie plates, etc., can be riveted by this method. The "Isherwood system" of longitudinal framing with the many built-up girders, transverses, stringers, and longitudinals offers every opportunity for compression riveting.

Have a special gang to rig up frames*, supports, cranes, and trolleys. Do not let machines stand idle while riveting gangs adjust support. Idle machines steal your profits. Functional management, with one man or gang doing one thing, is the keynote to efficiency.

Some Methods to Assist in Meeting Competition

Cutting down the operating cost of riveting is by no means new, nor are the ideas or methods new, but as the same old methods prevail they will be immediately pointed out as being impracticable. Why? Because shipbuilding methods in the United States have got into a rut—so to speak.

Not only are these methods practicable and absolutely certain of being put into effect in the near future, but it will not be surprising to see plating put on a strake at a time and secured by yoke riveting.

Fabricating structural work on the ground has been a means of large savings, and a greater percentage of a ship can be thus assembled by employing a special mechanic to develop the extension. The saving will more than offset the expense.

An article appeared in one of the Philadelphia newspapers recently on the relative cost of shipbuilding here and abroad, bringing out the fact that shipbuilders in the United States are not able to compete with foreign producers. Riveting being the most important single subject, it can be taken first and mastered in all its details, then let the minor subjects follow. The reduction in cost that

* Pipe frame and balance lever supports for this type of work are manufactured by Ridgely & Johnson Tool Co., Springfield, Ill.

would naturally follow this would be a big help toward meeting competition.

Value of Tests and Investigations

The lack of pioneer work, tests and experiments in most shipbuilding plants is most conspicuous by its absence, as compared for instance with the Pennsylvania Railroad, which maintains a department of tests, the yearly expenditures for which pass the million mark; yet the money is considered well spent. The Champion Rivet Company,* in a pamphlet, furnishes data from the various tests of their rivets, and finish with articles on how to heat and drive rivets. As a further illustration that it saves money to spend money, a few of the accomplishments in various trades are quoted, all being more or less familiar to men interested in "management."

(a) When applied to the simple operation of loading by hand a railroad car with pig iron, the performance of the individual worker increased from 12.5 to 47 tons per day.—F. W. Taylor.

(b) When applied to shoveling coal, it doubled or trebled the performance of the shoveller.—F. W. Taylor.

Mr. Gilbreth says of Mr. Taylor: "Much toward standardizing the trades has already been done. In this, as in almost countless other lines of activity, the investigator turns oftenest with admiration to the work of Frederick W. Taylor. It is the never ceasing marvel concerning this man that age cannot wither or custom stale his work. After many a weary day's study the investigator awakes from a dream of greatness to find that he has only worked out a new proof for a problem that Taylor has already solved."

(c) When applied in the manufacture of cotton goods, it increased the output 100 percent.—Scheel.

(d) When applied in the manufacture of machinery, 75 men in the machine shop, with 20 men in the planning department, do two or three times as much work as 105 men in the machine shop did under the old methods.—Hathaway.

(e) The standard study has increased the average life of belting more than sixfold; has reduced belt failures to 1-6 of what they were and has decreased the known cost to less than 1-7.—Emerson.

Shipbuilding work can be standardized to the same degree that has marked the increased efficiency in other lines of effort by applying "scientific management," as present writers have termed these "scientific studies and investigations." "The Art of Estimating," by Naval Constructor William B. Ferguson, U. S. N., recently published by the Engineering Magazine Company, deals with the standardization of shipbuilding operations.

Efficiency Records of Workmen.

Without keeping records of daily outputs, it is impossible to tell if a gang is doing a fair day's work. Many workmen bluster around and seem exceedingly busy with their many useless motions, while others watch the boss and appear busy at the right time; then there are the men whose motions are slow and methodical. Which are the most impressive? The first two, by all means, but begin and keep records and see the result. Low efficiency will be readily detected by observing the daily records; reward or punishment can be given with a feeling of having done justice, and both the employer and employe will benefit by the increased efficiency when the men realize they will be rewarded for merit.

A simple basis to arrive at the percentage of efficiency is to take a gang's earnings and divide it up according to the division of pay, then divide the individual earnings by the per diem pay.

If a gang's performance is counted daily and entered on "individual efficiency records," the records to extend over a period of one month, sheets will show at all times the daily efficiency, also the attendance records. The attendance record can be divided into "leave with permission," "leave without permission," "bad weather," and "total days worked." Each of the four, divided by working days of the month, will give percentage.

Relative Cost of Two Jobs; One by Day Work and the Other by Piece Work. Total Rivets, 117,000

(*See Curves*, Fig. 1)

The curves (Fig. 1)* do not represent anything more than an average cost. The number of rivets are abscissae and the cost of rivets ordinates. On any one line the ordinate divided by the abscissae will give the same unit cost. As both the jobs, one by piece work and the other by day work, are identical in number and conditions, the lines give a graphical idea of the relative cost of day work and piece work.

The first dot and dash line, measured along the ordinate *A*, gives the total cost of job, direct labor, piece work; the unit cost being $\frac{2{,}780}{117{,}000} = 2.375$ cents. The first full line, measured along the ordinate *D*, gives the total cost of the job, direct labor, day work; the unit cost being $\frac{3{,}830}{117{,}000} = 3.275$ cents. As eminent an authority as Mr. Church,† in his discussion of the Halsey, Rowan, Emerson, Gantt and straight piece work methods of bonus payment, ignores this fact; the difference in this case being nearly 38 percent.

Overhead expenditures on this job were prorated by percentage for the entire shop; in this average being included, hand tool men, pneumatic tool men and men using expensive machinery. The total overhead divided by total labor at this time giving an overhead expense of 35 percent of labor, the result being that sums of $1,340 and $973, respectively, were distributed to the day work and piece work jobs. This is represented by *G* and *H* on the curves. By taking 35 percent of the direct labor unit cost of rivets, the indirect expense per unit as above will be found showing that the overhead, by this method, varies according to the direct labor cost per unit.

When a riveting gang is considered as a production center and the factors reduced to an hourly basis, the ordinates *B* and *F* represent work's costs for piece and day work. *B* minus *A* and *F* minus *D* will give the overhead charges due to the machines being burdened with an hourly charge of 60 cents.

By using the percentage method of distribution, *C* for piece work and *F* for day work, is the portion of overhead not distributed to its proper source. The production factor method of burden includes all the expenditures due to the operation of a production center, such as land factor, interest and capital outlay, depreciation, repairs, power, fuel, oil, waste, a portion of tool room charges, supervision and general charges. A machine then carries a constant hourly charge, idle or in use; idle time being carried as a supplementary rate, which should

* Some valuable facts and varied practical opinions on driving and heating steel rivets are published by the Champion Rivet Company, of Cleveland, Ohio, in a pamphlet edited by them.

* When referring to work's cost, direct labor and overhead charges are included. Cost of material, although part of work's cost, has been intentionally left off to compare direct labor and overhead.

† "The Science of Management," by Mr. A. Hamilton Church.

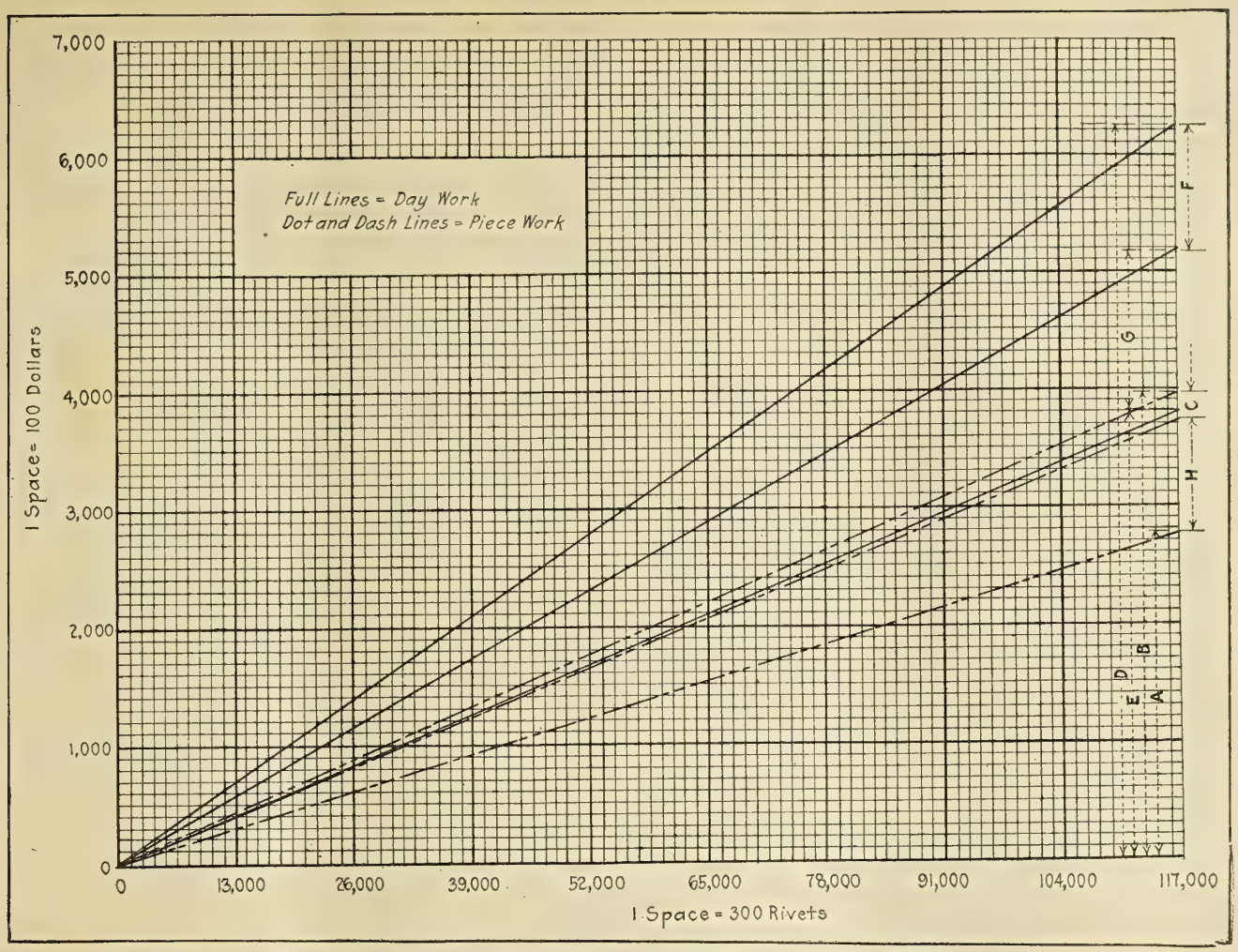


Fig. 1.—Cost Curves for Driving Rivets by Day Work and by Piece Work

be charged to profit and loss, and not prorated; as it has served its purpose when the amount is known and can be compared to periods. Hence, each production center then pays its portion of charges when the percentage method is eliminated.

Piece Work Accomplishments

On piece work the largest average efficiency obtained by a gang was 161 percent, or 61 percent over day's pay. average earnings for all gangs being 50 percent over day's pay, average pay being $11.20 per diem (this includes passer boys, who do not share in piece work); $2,780 total cost, divided by 11.20 = 248 man-day's of 8 hours or 1,984 man-hours, at $.60 (hourly burden) = $1,190.40.

Day Work Costs

$3,830 total cost, divided by $7.60, average daily pay of day work gang, = 504 man-days or 4,932 man-hours, at $.60 = $2,419.20 overhead charges.

Comparisons

Piece Work

Direct labor, cost per rivet in cents	2.375
Overhead labor, cost per rivet in cents	1.02
Number of man-day's work	248
Average daily performance (rivets)	472

Day Work

Direct labor, cost per rivet in cents	3.275
Overhead labor, cost per rivet in cents	2.07
Number of man-day's work	504
Average daily performance (rivets)	232

Results

A saving of 38 percent in direct labor with gangs' earnings 50 perecent over day's pay, a net saving of 103 percent on overhead and a saving of slightly over 50 percent on work's cost. Number of day's machine time less than ½ and daily gang performance more than double.

Reducing Cost by Checking Records

For estimating purposes and a check on work, a checking sheet can be made and kept up at a very small cost. The checking sheet used on the piece work job previously discussed is shown on page 412. No attempt has been made to alter or perfect the sheet; it is shown exactly as used, with all its imperfections.

The different classes of riveting are entered in column, "Description of Work," checking being done in a horizontal line opposite each class, the date and number of rivets driven being checked off; to economize space the checking is made in the form of a fraction, month and day being the numerator, the number driven, the denominator.

Example, $\frac{5\text{-}10}{4\text{-}20}$, i. e., the fifth month tenth day 420 rivets; unit prices are then entered from the piece work schedule, the number of odd rivets estimated and the amount of ground riveting determined. Thus the cost is predetermined; estimating the number of odd rivets is simplified, if accurate past records have been kept, it will be noted under operation 48 that the estimated number of odd rivets is 2,000, whereas only 179 developed, showing that past records and judgment were far from accurate.

J.O. A-L / 7 K
Date
Begun
Complete

Specifications
Provide and drive all Rivets
G = Ground Work
S = Ship "

117,843 Estimated No.
117,475 No. Driven
368 Diff.

Estimated No. Odd Rivets 2,000
Actual No. 179
Diff. 1,821

Oper No.	Oper	Allow	Unit	Unit Price	No Units	Total Price	Symb	Class	Size	Description of Work
1	Rv.	0	Rivet	0.0175	9.048	158.34	G	2	5/8"	Riveting B.H.(on Ground)
2	do.	0	"	"	1026	17.96	G	1	3/4	3/4" Rivets Top of Girder Plate, on Ground
3	"	0	"	"	1666	24.99	G	1	5/8	Rivets in Angle under Deck to Truss, on G.
4	"	0	"	"	846	14.81	G	1	3/4	Rivets to Truss Angle at Top
5	"	0	"	"	720	12.60	G	1	3/4	Brackets in Trusses
6	"	0	"	"	432	7.56	G	1	3/4	Butts and Laps in Bottom Truss Plates
7	"	0	"	"	618	10.82	G	1	3/4	Bottom Truss Angles
8	"	0	"	"	416	7.28	G	1	3/4	Angles Bottom C.L. of Truss
9	"	0	"	0.015	1074	16.11	G	1	5/8	Angles top of Truss to Deck Beam Clips
10	"	0	"	"	674	10.08	G	1	5/8	" " End of Side Truss to Deep Brackets
11	"	0	"	"	1600	24.00	G	1	5/8	Angle Top of Floor to Truss
12	"	0	"	"	316	4.74	G	1	5/8	Deep Brackets to End Brackets & End Brac. Clips to Deck
13	"	0	"	"	216	3.24	G	1	5/8	Vertical Angles to Deep Brackets
14	"	0	"	0.0175	2142	37.49	G	1	3/4	Beam Brackets to Beam & Clips to Beam
15	"	0	"	0.0175	2856	49.98	G	1	3/4	Brackets Channel Floors to Angle Framing
16	"	0	"	0.02	272	5.44	G	2	3/4	Fender Butts Straps
17	"	0	"	0.0175	720	12.60	G	1	3/4	End Framing
18	"	0	"	0.015	1596	23.94	G	1	5/8	Angles to Flashboard Brackets (Deck Flange of Clips
19	"	0	"	0.025	252	6.30	S	5	5/8	Rivet Collar to BH. on Ship. not included)
20	"	0	"	0.0275	576	15.84	S	5	3/4	Truss to B.H. Clips
21	"	0	"	0.02	96	1.92	S	3	3/4	End Laps C.L. Truss
22	"	0	"	0.025	900	22.50	S	5	5/8	Clips C.L. of Truss including Flange to Floor
23	"	0	"	0.025	1980	49.50	S	5	5/8	Clips to Side " " " " "
24	"	0	"	0.025	612	15.30	S	5	5/8	" " " & C.L. Truss at Top (Beam Flange not
25	"	0	"	0.02	704	14.08	S	3	5/8	Side Truss & all Connections included)
26	"	0	"	0.02	1224	24.48	S	3	5/8	Beam Brackets to Frame
27	"	0	"	0.0225	10974	246.92	S	3	5/8	Decks
28	"	0	"	0.02	20314	406.28	S	3	5/8	Decks
29	"	0	"	0.02	1144	22.88	S	3	5/8	Rider Plates to C.L. Truss Angle & Floor
30	"	0	"	0.0225	6954	156.47	S	4	5/8	Shell, Side
31	"	0	"	0.25	7312	182.80	S	4	3/4	" , "
32	"	0	"	0.028	160	4.48	S	4	7/8	" , "
33	"	0	"	0.0225	19392	436.32	S	4	5/8	Shell, Bottom
34	"	0	"	0.025	4648	116.20	S	4	3/4	" , "
35	"	0	"	0.0275	9630	264.82	S	5	3/4	Fender including End and Corner Casting
36	"	0	"	0.02	576	11.52	S	3	3/4	End Framing to Channel Floor
37	"	0	"	0.02	160	3.26	S	3	3/4	Clips to Bottom Brackets of Frame No. 2, 3, 52, 53.
38	"	0	"	0.0175	949	16.61	S	3	5/8	Angles, Tie Plates Brackets, (Beams & Clips to
39	"	0	"	0.0225	416	10.40	S	5	5/8	Coal Scuttles Lower Deck)
40	"	0	"	0.036	16	0.58	S	5	1	Davit Step
41	"	0	"	0.0275	32	0.88	S	5	3/4	Chain Pipe
42	"	0	"	0.031	72	2.23	S	5	7/8	30" Cleat
43	"	0	"	0.038	32	1.23	S	8	3/4	Roller Chocks
44	"	0	"	0.0225	160	3.60	S	3	3/4	Bitt Foundation Angles to Deck
45	"	0	"	0.038	264	10.03	S	8	5/8	Clips to Bitt Chuck, Roller Chuck, & Mooring
46	"	0	"	0.025	56	1.40	S	5	5/8	Pad Eye for Stowing
47	"	0	"	0.05	420	21.00	S		5/8	Rivets in Flash Board J.O. A-3 / 11
48	"	0	"	0.07	2000	140.00	S		5/8 & 3/4	Odd Rivets
					117,843	2630.74				2630.74 / 117,843 = 0.0223 Unit Price

5-6 840 | 5-9 610 | 5-22 304 | 5-23 1400 | 5-24 2200 | 6-2 600 | 6-4 1411 | 6-9 1004 | Total 9,029

Records from Checking Sheets

	No. of 5/8"	No. of 3/4"	No. of 7/8"	No. of 1"	Total No.	Total Cost	Unit Cost	Per Cent of Total Rivets
Ship Rivets	53,681	36,261	236	16	90,194	$ 2,225	0.025	0.7675
Ground Rivets	16,890	10,212			27,102	442	0.0167	0.231
Odd Rivets	89	90			179	13	0.07	0.0015
Totals	70,660	46,563	236	16	117,475	(1) 2,680	(1) 0.226	

(1) Pay of Passer Boy's not included

Fig. 2.—Checking Sheet

Column (1) is operation number, this number is used in addition to the job order number on time cards, return costs being made by operations in addition to total costs by job order. Counting from the left column, 2, 4, 5, 6, 7, 8, and 10, are self-explanatory. An explanation of column 3, allowance, and column 9, class, will not be given, as they are not essential for understanding the sheet, although these columns were used in connection with piece work schedule and are fully described on pages 38, 39, 40, and 44 in the book by Mr. William B. Ferguson, previously referred to.

The sheet on which daily entries are made is pasted to the right of the blue printed sheet. Counters turn in the previous day's work before 9 A. M. to the official in charge of work, who checks off the performance and makes out time tickets to cover completed work. Time tickets are then sent to accounting officer.

When any great variation between the estimated numbers and actual numbers occurs, the reason can be thoroughly investigated, which will show that the estimated number is incorrect or that riveters have been getting two for one, or three for two, in close places. The checking therefore becomes a protection and shows just what occurs.

Sheets covering the entire job were made up in this form and the work counted and checked. The increased production was actually surprising, due to every employe's daily performance being daily scrutinized by some one in authority. The entire cost of this preliminary work, including the ordering of material, was 7-10 of 1 percent of the direct labor cost. As this is the first work of this kind ever attempted, it is believed that this cost can be materially reduced by continuing and the men becoming more proficient. The checking sheets are useful to the management in the following ways: Unless you know what was done on the last ship, no comparisons can be made (not considering as comparisons the results obtained by dividing the riveting costs by the supposed count, with no check). It is characteristic of the human nature to try and excel past records, so by making these past performance records so plain and distinct, enabling a foreman to see at a glance how much he is gaining or losing, you insert the human element. The records*

* The necessary records are illustrated on checking sheet.

should therefore show the number of rivets driven on ground, diameters of rivets (as cost of similar conditions vary by diameters), total cost, and unit costs of this class; also the number of odd rivets and the number of rivets driven on ship, their total and unit costs, the same for a grand total. As a final comparison take the grand total, and from the odd, ground, and ship totals obtain the percentage of each of the grand totals. The high unit cost of odd riveting (due to preparation cost) and the reduction in unit cost for ground work, overhead done on ship, would immediately assert themselves and show that the way to obtain reduced unit cost is by studying conditions and concentrating on reducing the numbers of former and increasing the latter.

The number of rivets on the "checking record" checked off as being driven will give a good idea of the percentage of completion of structural work.

Results of Overhead Distribution

Overhead charges by the production center are useful to compare with actual happenings. The hourly charge of 60 cents is an approximation, but is being worked out. Charges were made against the two jobs illustrated by the percentage plan; by this method results incidental to production cannot be shown. As an illustration, take direct labor, the saving is 38 percent; then take the overhead charges (35 percent of direct labor), again you get 38 percent. Now add direct labor and overhead charges and for the third time you get 38 percent. Under "comparisons," note the results and it will be readily understood that time is more a factor of burden than direct labor.

Low bungling, inefficient labor, dragging out a job, cannot be shown by comparison of overhead charges to be expensive—pay an inefficient man low wages, let him use and abuse your expensive pneumatic hammers and waste power—not as many rivets are driven, but it takes longer to drive them. Comparing low wages and inefficient performers with higher paid, efficient men, direct labor per rivet might be the same, but how about overhead charges? On the percentage plan the charges would appear identical, but the production center method will show the true state of affairs, that the bungler is using two hours of machine time to do one hour's work. This demonstrates that efficient men are economical, even if higher paid, so why not consider them as partners by dividing savings as follows:

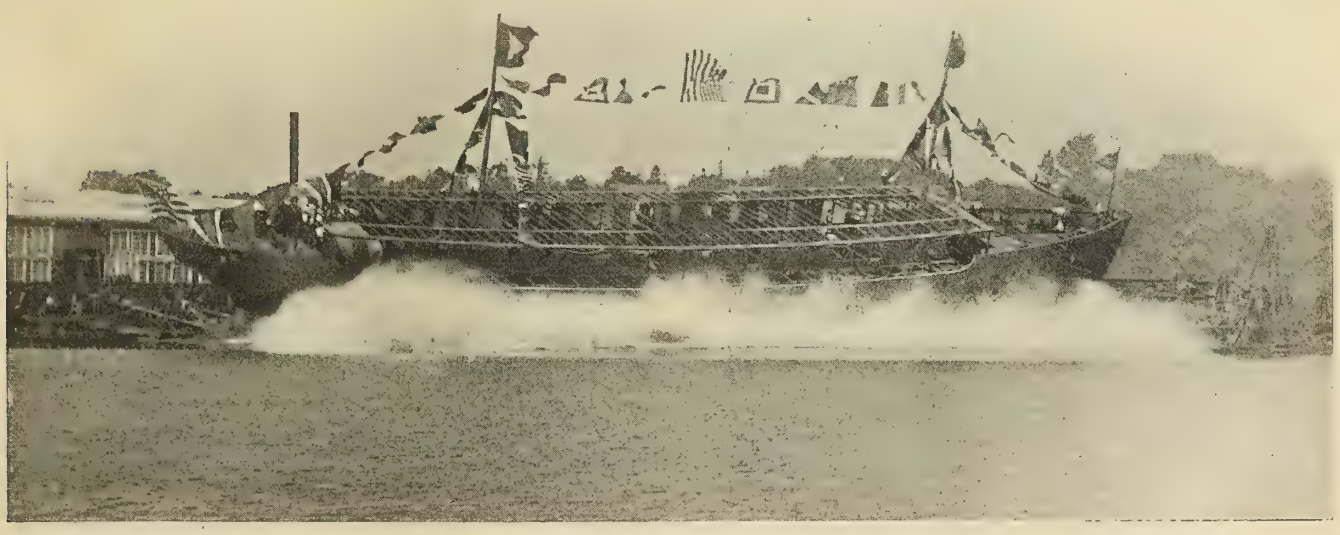
First determine hourly overhead charges on your machines, set tasks by piece work schedule, bonus to begin when day's pay has been equaled, share equally with men the saving in both direct labor and machine time, gangs then get straight piece work price per rivet until reaching 100 percent efficiency; beyond this they share in the machine time saving. Under no circumstances cut wages because men, through skill and effort, increase their earnings. Exorbitant earnings are not possible with the piece work prices in vogue at the different shipyards, but skilled men can and will further increase your dividends and their earnings if assured fair play. When new and improved equipment is installed that will lessen labor and increase outputs, new factors and unit prices must be determined; this should not decrease the men's earnings, although the output is increased.

If a workman by some improvement of his own and at no expense to the company should increase his earnings, wages should not be cut, this discourages improvement; besides, the company is sharing the increased profits.

The fluctuating of overhead charges absorbed by a machine on the percentage plan may be further illustrated by the day work and piece work pay on job in question. Taking 35 percent of labor in each case we get $3.73 charged to piece work and $2.39 to day work. This makes cheap labor appear efficient.

Cost of Hand and Machine-Driven Rivets

When the high hourly charges incident to driving rivets with pneumatic hammers are charged to their proper source and not spread over the works, and low charges incident to hand riveting are charged properly, it would be interesting to know accurately which is the most economical on certain classes of work, particularly oiltight work and watertight work, when the high cost of



Launching the S. S. *Surveyor* at the plant of the Manitowoc Shipbuilding Company

The *Surveyor* is a steel steamer 186 feet long, 34 feet beam and 11 feet 6 inches draft, of 1,000 tons displacement, being built by the Manitowoc Shipbuilding Company, Manitowoc, Wis., for the United States Coast and Geodetic Survey for service in Alaskan waters. The vessel was launched on July 22 and christened by Miss Elizabeth Brent Jones, daughter of Dr. E. Lester Jones, superintendent of the United States Coast and Geodetic Survey.

COALING SEA-GOING VESSELS IN MOBILE HARBOR



Fig. 1.—Maxine Mine Washery



Fig. 2.—Loading Barges at the River Tipple

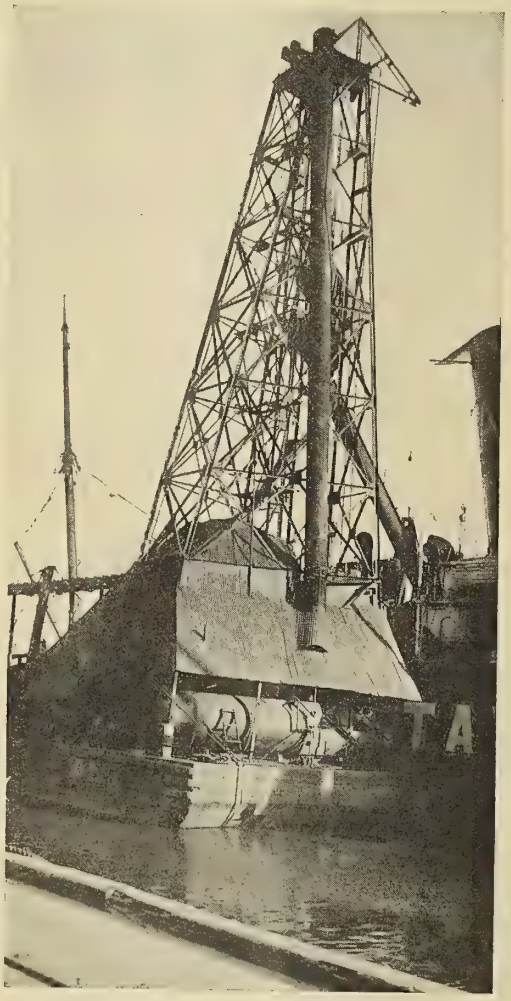


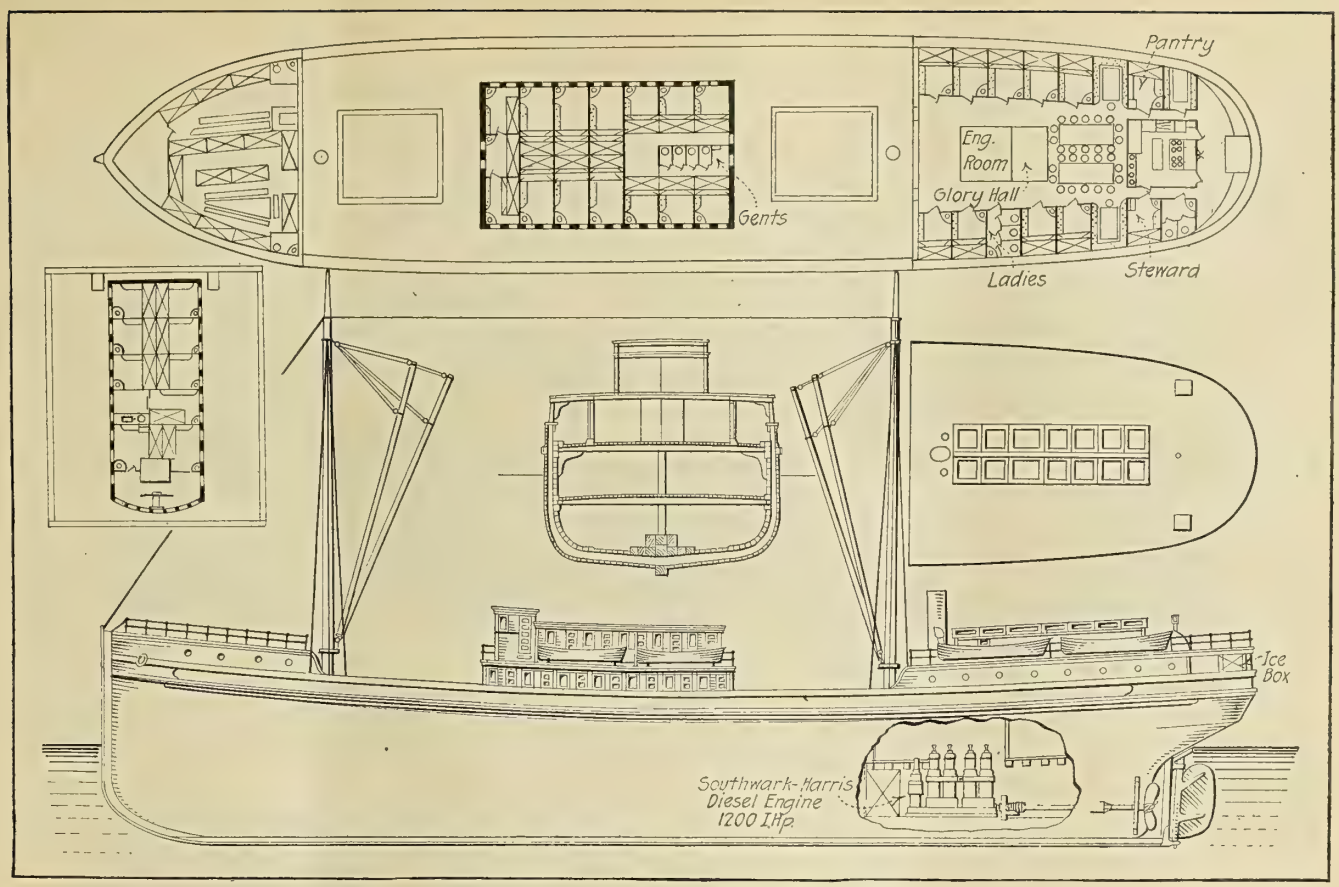
Fig. 4.—Bunkering Vessels at Mobile



Fig. 3—Making Up a Tow at the Tipple



Fig. 5.—Sea-going Coal Barge



General Plans of Large Wooden Motor Ship

tests is considered. It is a known fact that hand rivets draw up and insure tighter work than pneumatic hammer-driven rivets for this particular class of work, which is a very small portion of the rivets in a ship, but a very important part.

Although the writer does not have the facilities at his disposal to solve this, nevertheless the solution would be valuable if someone having the opportunity and means becomes interested enough in "riveting" to work out the results. If all would contribute their mite toward the standardization of operation, beneficial results are likely if not certain to follow every intelligent effort in this direction.

Coal Handling at Mobile, Ala.

The several illustrations on the opposite page show views of the various operations in handling coal at the mines of the Pratt Consolidated Coal Company at Maxine, Ala., and during its transportation to Mobile and its transfer to vessels in Mobile harbor.

Fig. 1 shows the Maxine mine electrically-driven washery where "Little River" coal is prepared for shipment by barge line to Mobile. The river tipple, where the coal is loaded on barges, is shown in Fig. 2. Fig. 3 shows a sternwheel towboat making up a tow at the tipple and Fig. 4 shows the collier *Blossburg* bunkering ships at Mobile. This collier has a capacity of 1,000 tons and will handle the coal at the rate of 150 tons per hour.

In Fig. 5 is shown the sea-going barge *Harry Morse*, which is used for transporting the coal from Mobile to Cuba and other points on the Gulf of Mexico. The Pratt Consolidated Coal Company has two other barges of this type. The barges are towed by the sea-going tug *Asher J. Hudson*.

L. E. G.

Large Motor Ship Building in Seattle

What is said to be the largest wooden motor ship so far built in the United States is under construction at the yards of Nilson & Kelez, Seattle, Wash., for the Alaska-Pacific Navigation Company, of Seattle. The vessel is 232 feet long, 42 feet beam, 23 feet molded depth, with a load draft of about 18 feet, and was designed by Mr. R. M. Semmes, vice-president of the Alaska-Pacific Navigation Company. She will be propelled by two 625 indicated horsepower Southwark-Harris heavy oil engines, manufactured by the Southwark Foundry & Machine Company, of Philadelphia.

The boat is designed for a speed of about 11 knots and will be used for lumber carrying and general cargo and passenger services. She will have a freight capacity of 1,800 tons deadweight, and, owing to the small space required for the propelling machinery, will be able to handle 1,500,000 feet of lumber. Cargo will be handled through two hatches, each of which is equipped with two 6-inch by 9-inch Heffernan winches, supplied with steam by an auxiliary steam plant which will also provide steam for heating and for the electric plant.

Memorial to Sir William White.—At the Institution of Civil Engineers, London, on July 26, Admiral Sir Reginald Custance formally presented to the Council of the Institution a medallion portrait of the late Sir William White, which has been provided out of a fund collected from all parts of the world to commemorate the work of the late naval constructor. The medallion bears two inscriptions. Above the portrait of Sir William are the words, "Build Staunch and True," while beneath the portrait is the following: "Sir William Henry White, K. C. B., LL. D., D. Sc., F. R. S., President 1903-4, Director of Naval Construction, 1885-1902. A tribute from the shipbuilders and engineers of many nations."

LAKE WASHINGTON CANAL AT SEATTLE, WASH.



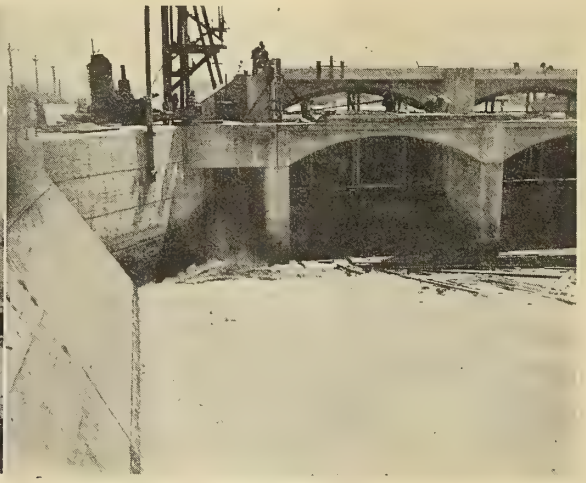
Power Station



Lock Superintendent's House



The Spillway (Salt Water Drain at the Left and Fish Ladder at the Right)



Mouth of Salt Water Drain and Portion of Spillway



Large Locks Filled. To the Left Is Entrance to Auxiliary Lock



Official Opening of the Canal. S. S. *Swinomish* Passing Through the Locks



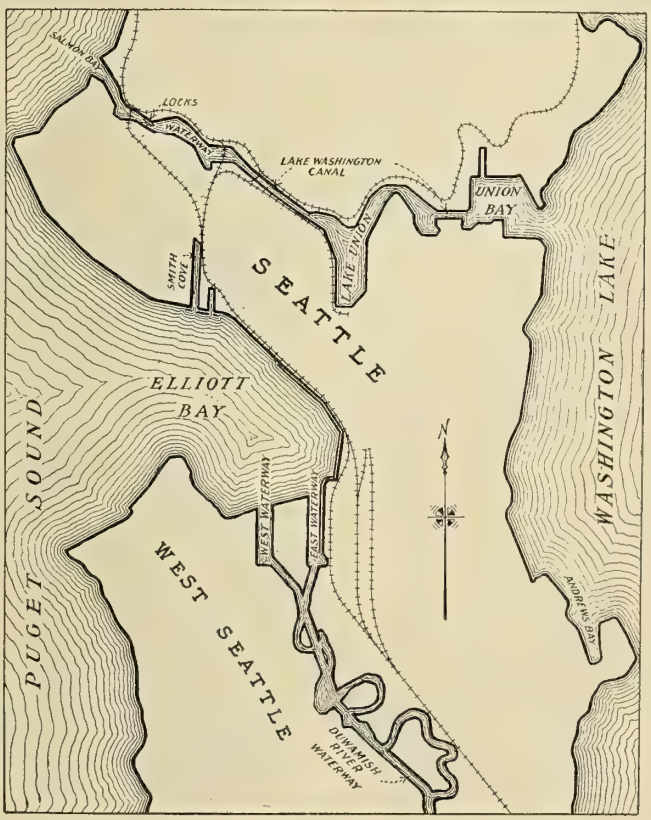
Completion of Lake Washington Canal

Opening of the Canal Makes Over Sixty Miles of Additional Water Frontage Available to Seattle's Shipping and Shipbuilding Industries

BY GILBERT C. DOHM *

WITH the formal opening of the first unit of the Lake Washington Canal on August 2, 1916, Seattle, Wash., now has prospects of some day becoming the New York of the Pacific Coast and the terminus of most of the Pacific Ocean's steamship travel. On July 30 the auxiliary lock leading to the canal was opened and the steamer *F. G. Reeve* made the first passage through the lock. August 2, however, was the gala day, when the United States Corps of Engineers' boat *Swinomish,* accompanied by the cruiser *Orcas,* passed through the main lock and officially opened it to all ships and for commercial use.

* The writer of this article is indebted to Mr. C. A. D. Young, assistant engineer and designer of the gates and machinery for the lock, for much of the information contained herein.



Map Showing Location of Lake Washington Canal

Increase of Commercial Waterfront

The former natural shore front of Seattle on Elliott Bay, available for use in the shipping and manufacturing industries, amounted to about 4½ miles, compared to the 45 miles of New York's first-class frontage. The rest of the territory bordering along Elliott Bay and adjacent to Seattle is either filled in or is hilly and precipitous, and the expense involved in the removal of such natural formations without the subsequent gain of much territory did not warrant this undertaking. With the opening of the canal, however, some 60 miles or more of extra waterfront territory is made available to shipping interests, while 12 miles of that portion is already of a flat and desirable nature and has the advantage of railroad transportation and

cheap electrical power. The opening of such a vast territory will give to Seattle the permanent asset of having an area available for manufacture greater than any city in the United States.

Aside from the added advantage of increasing the commercial water frontage is the prospect of maintaining the largest fresh water basin in this country where ships for ocean travel can anchor or load and at the same time free their underwater bodies of sea growths to some extent, without the actual cost of drydocking. Whether or not



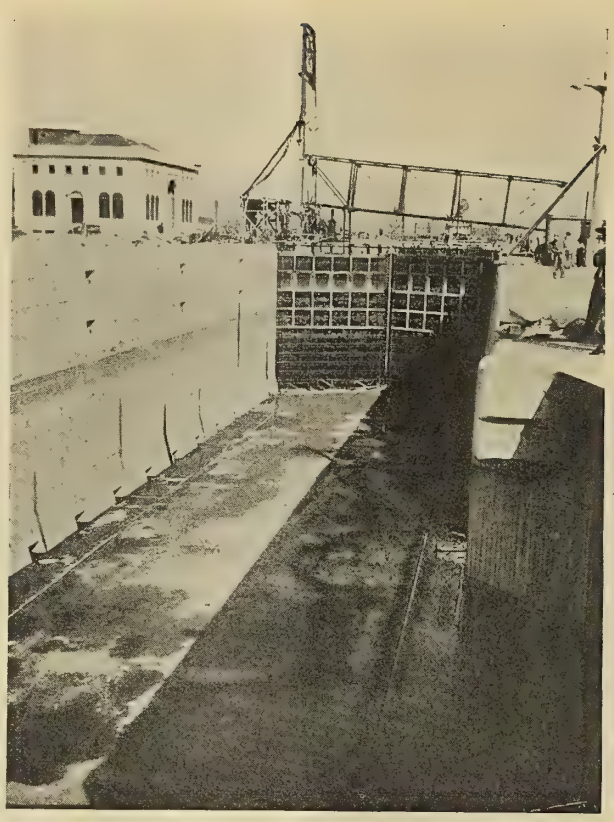
Auxiliary Lock—Gates Closing

Lake Washington and Lake Union, which are connected, will remain fresh water, is a topic of some discussion, as the method of draining off the salt water seepage from the Sound is purely experimental. Should this be the case, however, combined with the economies of a constant water level basin, with no variation due to tide, this is a factor not to be overlooked.

Elliott Bay, while possessing many advantages as a protected harbor, has one great disadvantage in the extreme depth of its water and the consequent difficulty found in anchoring. The Lake Washington Canal will to some extent eliminate this difficulty in the case of ships intending to anchor for some time, by opening up these two fresh water basins with their first-class anchorage facilities.

Eliminating Flooded Areas

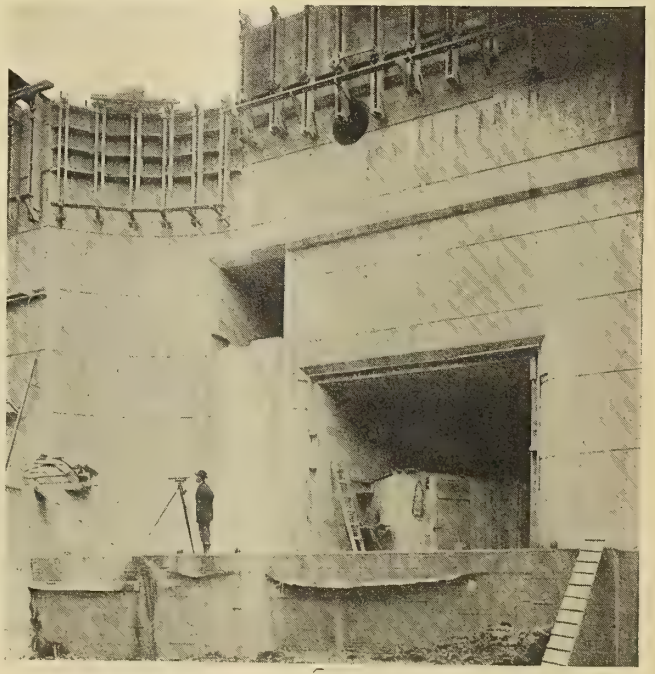
In the lower Lake Washington region floods have been prevalent, due to the swollen conditions of the Duwamish River. As the level of Lake Washington will be decreased from 8 to 9 feet, the Cedar River, which now empties into the Duwamish and Black rivers, will change its course and empty into Lake Washington, reducing the volume of the Duwamish River some twenty-five percent, thereby eliminating to a great extent the cause of these flooded conditions. This decrease in the level of Lake Washington will also tend to drain off many of the swampy districts, thus converting such territory into high and dry ground.



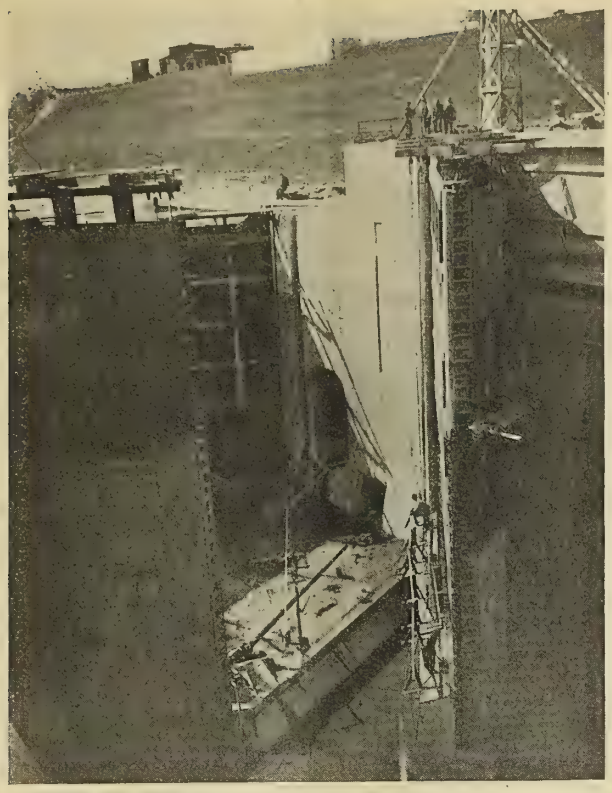
Large Lock Empty. Mid-Length Gates in Background

Portion of Salmon Bay Made a Fresh Water Basin

The canal locks are located about midway up Salmon Bay. When the canal connecting Lake Union with Salmon Bay was opened, that portion of Salmon Bay above the locks became a fresh water basin and assumed the same level as Lake Union. At high tide the difference in the water level between the lower end of Salmon Bay and that portion above the locks is about 8 feet. Upon completion of the canal connecting Lake Washington with Lake Union, the level of the water in Lake Washington will lower itself about 8 or 9 feet and assume the level of Lake Union.



Upper End of Large Lock, Showing Filling Culvert



Gates of Large Lock Open. Inside Are Guard Gates and Culvert for Filling

Locks Among the Largest of Their Kind

The canal locks are two in number and side by side. The larger one, which is 825 feet long by 80 feet wide and 55 feet deep, opens into a channel 36 feet deep at the Puget Sound end. It is fitted with a set of operating gates weighing about 230 tons apiece, at either end and at mid-length. The mid-length gates are used when ships under 375 feet long, but too long for the auxiliary locks, pass through. The machinery, which is all electrically operated from stations along the lock, is housed in the walls of the lock, which are about 55 feet thick at the bottom and 8 feet thick at the top.

Provision has also been made for using the lock in case of necessity for a dry dock, by fitting at either end a guard gate which opens outward. Two 30-inch pumps are used to empty the lock, the time consumed being about eight hours.

The auxiliary lock, capable of taking boats up to 16 feet draft, is 130 feet long and 30 feet wide.

Both locks are filled with water from Lake Union and emptied into the lower end of Salmon Bay by the gravity system through culverts in the bottom of the side walls, the culverts having openings at constant intervals which lead into the lock. No pumps are therefore required to fill or empty the lock. In the large lock the operation of filling and emptying requires from five to eight minutes, according to the height of the tide.



Looking Down Inside the Fish Ladder. In the Lower Right-Hand Corner Is the Entrance in the Dividing Wall. At the End of the Ladder Is the Entrance into Salmon Bay.



Lock Empty, wth Gates Open

In order to operate the locks at night, a series of high-powered lights stationed along the wall furnish the necessary illumination.

Abreast the locks lies the spillway, salt water drain and fish ladder. The spillway is about 150 feet wide and 30 feet deep. It will carry off all the overflow of Lake Washington and Lake Union and is provided with a gate to maintain a uniform flow for use in the generation of electrical energy.

Salt Water Drain

It was found that in the Panama Canal the salt water worked its way along to the fresh water lakes, killing the fish and ultimately changing the lakes to salt water basins. In order to eliminate this in the Lake Washington Canal, a large sump was built at the inner end of the locks. The salt water being heavier than the fresh water, will stay at the bottom and pass into this sump on

its way to the lakes. From the sump it will drain out through a tunnel which empties into Salmon Bay. The mouth of the tunnel is at all times higher than the high water level in Salmon Bay but lower than the level in Lake Union. Tests on water secured at the bottom of Lake Union after this method was in operation showed no trace of salt water, which leads to the belief that Lake Washington and Lake Union will always remain fresh water basins.

Fish Ladder

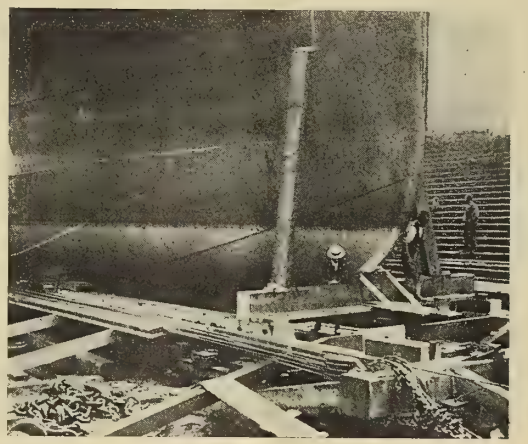
A unique feature of a portion of the locks is the provision made for allowing the fish to pass up beyond the spillway. For this purpose a so-called "fish ladder" was built. This consists of two concrete walls running parallel and in the same direction as the locks. The enclosure between these walls is divided into sections by another series of walls built in transversely and a little oblique to the first pair. In these dividing walls are cut entrances about 18 inches square, through which the fish pass, the entrance to each consecutive apartment being somewhat higher than the previous one, thereby gradually leading the fish up to the water on the other side of the spillway. Water is continually flowing from above the spillway into the ladder and through the entrances into Salmon Bay, but on account of the subdivisions in the ladder the initial head of the water is also divided and the consequent flow is not sufficient to hinder the fish. The ladder is open on the top to admit air and sunlight.

The work of building the canal was started in 1911, having been the source of much controversy and debate. The total project will cost in the neighborhood of $5,000,000 (£1,025,000). Seven hundred and fifty thousand dollars (£154,000) was appropriated by King County, in the State of Washington, and $250,000 (£51,000) by the State of Washington, the remainder being appropriated by the Government. The work is all of concrete and the locks are among the largest of their kind.

Cargo Steamer Lengthened Over 50 Feet and Converted Into an Oil Tanker

One of the liveliest pieces of ship repair work ever accomplished in a modern ship repair yard was carried out in the first two weeks of July by the Robins Dry Dock & Repair Company, Erie Basin, New York, in lengthening by about 52 feet the cargo steamer *George E. Warren,* a single deck steel ship of 2,306 gross tons, 246 feet 6 inches long by 43 feet 9 inches beam by 25 feet 3 inches depth. The vessel was built at a Toledo shipyard four years ago for the Atlantic Coast Gulf trade and is owned by the Boston-Virginia Transportation Company, New York. Recently the vessel was chartered for a long period for the transportation of oil in bulk, and it was decided to lengthen the hull by about 52 feet in order to increase the carrying capacity by about 1,000 tons. It was also necessary to convert the ship into an oil tanker by the installation of oil-tight bulkheads and oil-pumping arrangements.

The vessel reached the Robins dry dock on July 2 at 11 A. M., and by 4 P. M. the next day she had been cut

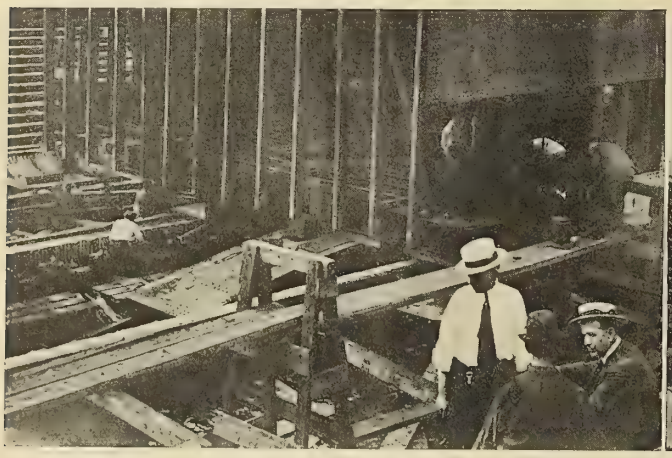


Tackle for Moving the Forward Section

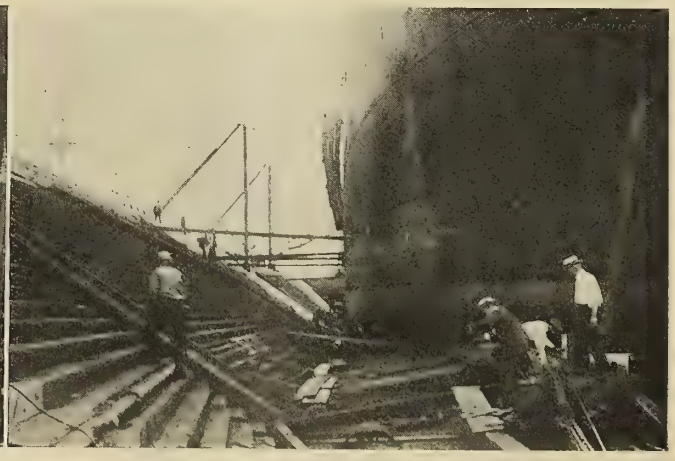
in two and pulled apart 52 feet and was ready to receive the new framing, flooring and plating. The actual time required to pull the two parts of the vessel apart was only 11 minutes.

This was accomplished by building on the bottom of the dry dock ground ways on which were built sliding ways for the forward section of the boat. The sections were hauled apart by means of block tackles and special winches, and any irregularities in the alinement of the sections was corrected by means of shoring and wedging.

That this work could be completed in the short space of about two weeks speaks well for the ingenuity and skill of the men who had the work in charge. The Robins Dry Dock & Repair Company, however, is accustomed to handle work of this character and the unusual facilities afforded at that plant make it possible to eclipse all records in the rapidity of such operations.

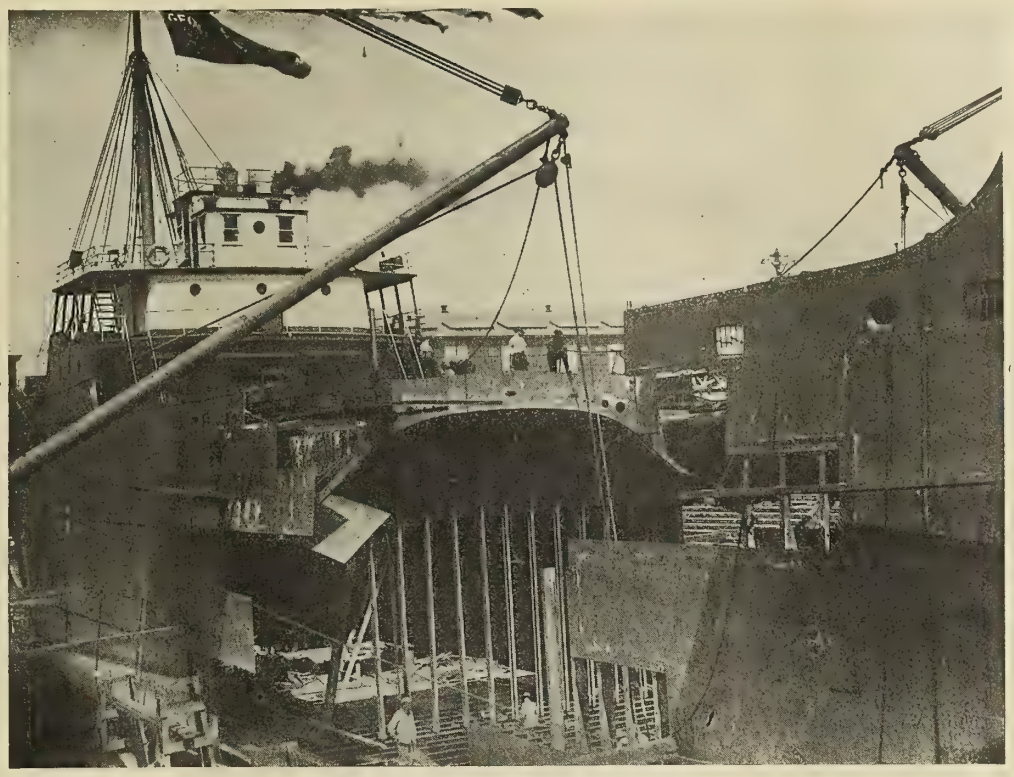


Preparing to Frame the New Section

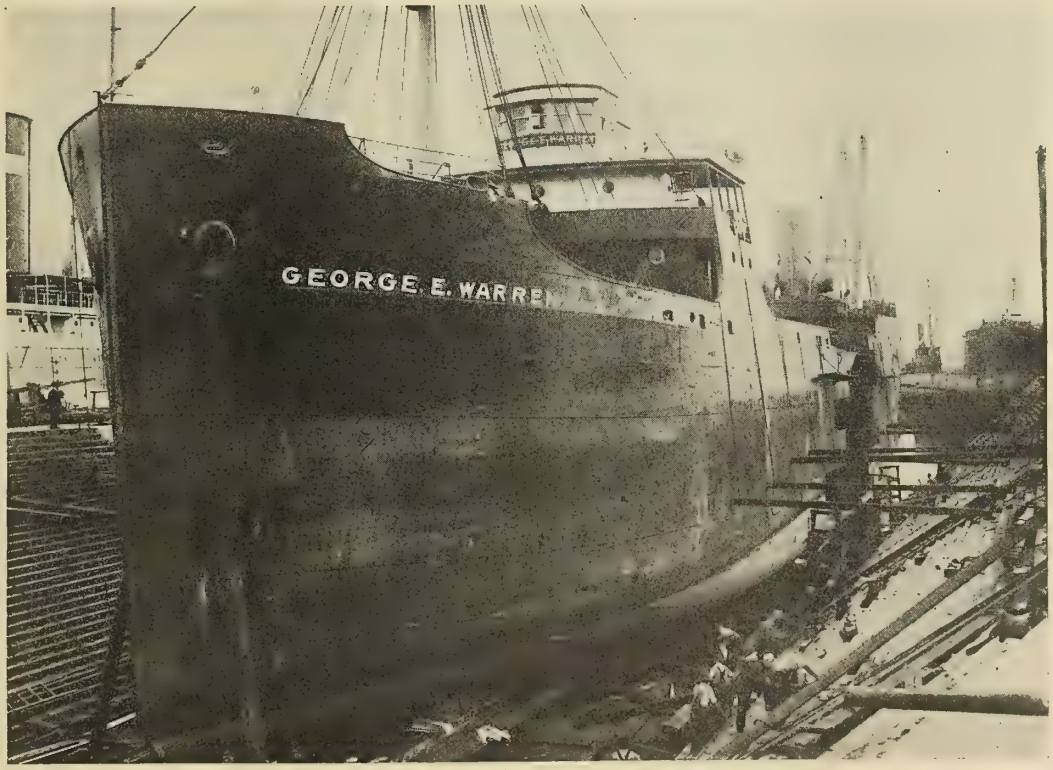


Rigging the Moving Tackle in Dry Dock

LENGTHENING AND REMODELING THE GEORGE E. WARREN



Building the New Section Amidships



S. S. *George E. Warren* in Dry Dock for Lengthening



Former Pacific Mail Steel Steamer S. S. *City of Sydney*, Converted into a Six-Masted Brigantine by Moore & Scott Iron Works, Oakland, Cal. Length, 339 Feet; Beam, 40 Feet; Depth, 20.5 Feet

New Plate and Angle Heating Furnaces Installed at the Cramp's Shipbuilding Plant

Among the recent improvements made in the extensive plant of the Wm. Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., is the installation of three large plate and angle heating furnaces furnished by the Metals Production Equipment Company, New York.

This new equipment includes one plate heating furnace with a heating chamber 9 feet wide and 36 feet long, and two angle heating furnaces, one with a heating chamber 30 inches wide and 81 feet long, and the other with a heating chamber 30 inches wide and 51 feet long. These furnaces all use oil for fuel in connection with air compressed at a pressure of about 10 to 12 ounces.

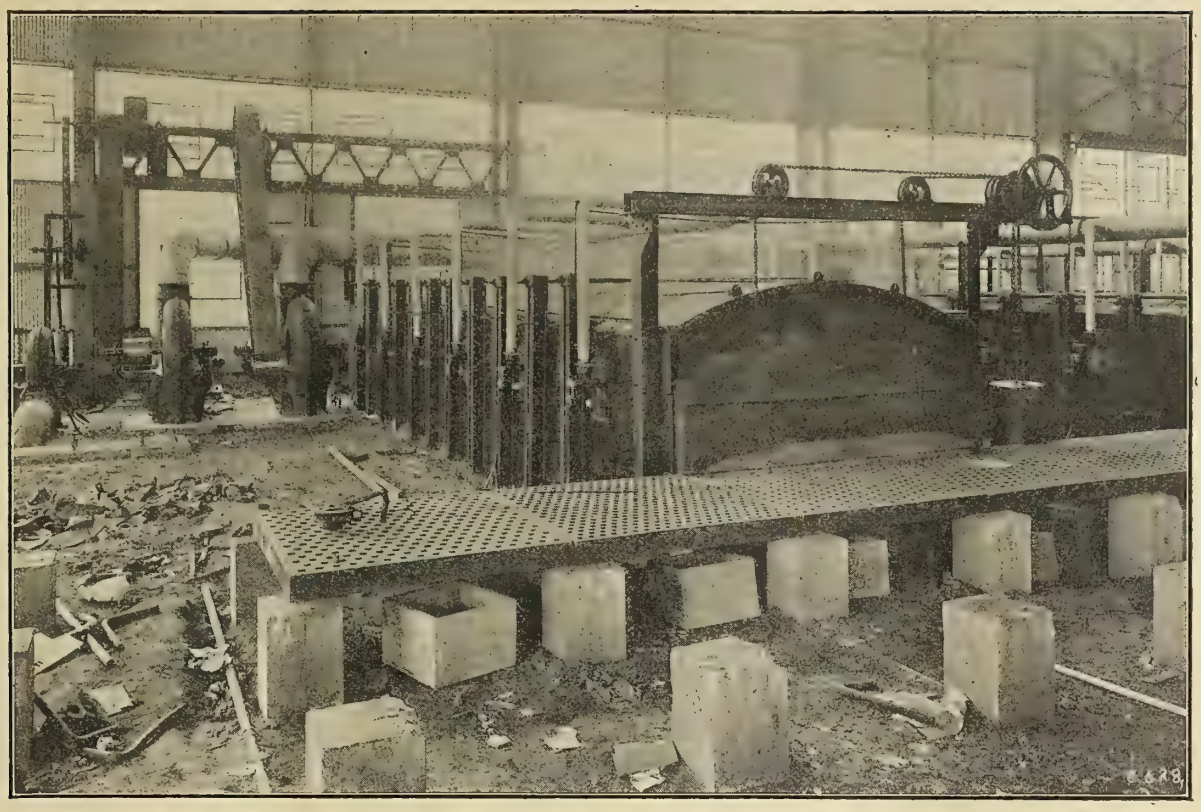
The oil is supplied by rotary pumps at about 25 pounds per square inch pressure, and the air is supplied by Sturtevant steel fan pressure blowers. Both the oil pumps and blowers are installed in duplicate to insure against a shutdown of the furnaces in case of accident. All of the furnaces have doors at one end only, the door opening in the plate heating furnace being only 22½ inches high in the clear, while the door openings in the angle heating furnaces are 25 inches high.

As can be seen from the illustrations, the oil burners are located on both sides of the furnaces and near the top of the heating chamber. The spent gas flues are in each side wall near the hearth level and pass under the hearth and up through each side wall to the atmosphere. The outlet of each flue is provided with a separate damper. With this construction it is possible to obtain a uniform heating condition in the working chamber, a hot hearth and a close control of heat circulation. By the proper use of the dampers, the heating chamber can be kept under pressure, which excludes excess oxygen and reduces scaling effect.

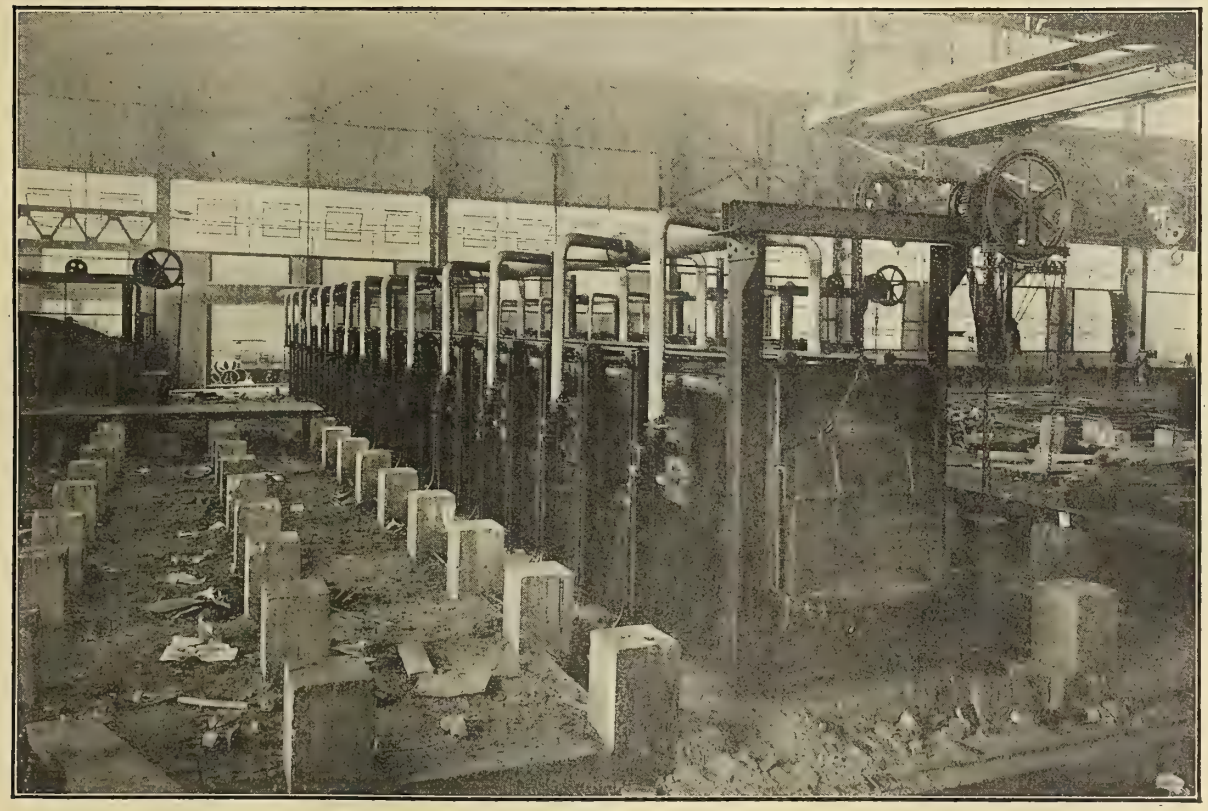
This arrangement of introducing the heat and controlling its escape makes it possible to carry different temperatures in different parts of the heating chamber or to heat only one part at a time if necessary, thus making it possible, as is frequently necessary in shipyard work, to heat the center or end of a long bar for flanging or bending operations without bringing the entire chamber up to the required heat.

For the economical operation of these furnaces, great care has been taken to reduce the loss of heat by radiation to a minimum. The best quality of fire brick is used in the walls and arches, and, in addition, a layer of special insulating brick is placed outside, forming a very effective heat-insulating medium.

The fronts of the furnaces are built of heavy cast iron and slightly inclined, so that the door is always in close contact with the front plates, thus preventing the escape of heat around the door. The doors are made in upper and lower sections, so that the lower section can be renewed when burned, without the expense of an entirely new door. Below each door a steel roller is provided to



New Plate Heating Furnace at Cramp's Shipyard



One of the Angle Heating Furnaces

facilitate the handling of material. The floors of the heating chambers are made of heavy hard-burned slabs, laid independent of the side walls to permit easy and quick renewal.

The furnaces are entirely encased in steel plates, so that no brickwork is exposed, and they are supported by I-beam buckstays, securely tied together with steel binding rods. The construction of the foundations for the bending slabs and the arrangement of the blower fans are clearly shown in the photographs on this page.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Comparison Between Pneumatic and Electric Portable Drills and Geared Hoists

Both pneumatic and electric portable drills are commonly used in shipbuilding, but owing to the fact that the initial costs of pneumatic and electric drills of the same power are about the same, the principal items for comparison in their operation are as follows: power consumption, durability, utility.

Portable Drills

For pneumatic drills the power consumption will be taken as the portion of the power of the motor driving the air compressor necessary for compressing to the required working pressure each minute the quantity of free air necessary to drive the drill under load. For electric drills the power consumption will be taken as the horsepower developed by the motor driving the drill under load.

The following table gives comparative results of three sizes of pneumatic and electric drills:

Maximum diameter of the hole drilled in mild steel plate	9/16	⅞	1¼
Revolutions of the drill per minute	500	300	200
Free air consumed per minute for pneumatic drill (with motor of four single acting cylinders), 90 pounds per square inch pressure, cubic feet	25	35	53
Consumption of power of the motor driving the compressor, for compressing to 90 pounds pressure the quantity of free air quoted above, horsepower	4.7	6.7	10
Power developed by the small motor driving the electroc drill working as above stated, horsepower	0.75	1.25	2
Proportion of power required for pneumatic drill in comparison with electric drill of the same drilling capacity	6.3:1	5.4:1	5:1

As far as the power consumption is concerned, it is found that pneumatic drills consume about five and a half times the power required for corresponding electric drills.

In regard to durability, it will be found that the electric drills are not as strong as the pneumatic drills, and frequently a workman using an electric drill will either by using it in an improper position, or else by forcing it beyond the limit of its capacity, burn out the motor and render the drill useless. On the other hand, if pneumatic drills are overloaded, they will stop without damage. Moreover, as nearly all of the electric drills used in shipyards have ventilated motors, due to the fact that a closed motor would be too heavy, the motors are easily damaged in damp weather by corrosion caused by the salt in the sea air circulating in the motor.

In the case of pneumatic drills there is little likelihood of serious damage to the flexible connection from the source of power to the drill. If there is slight damage to the flexible hose pipe conveying the compressed air to the drill, there will be simply a slight loss of air without other inconveniences. On the other hand, with electric drills, if the insulating cover of the wire conveying the electric energy to the drill is damaged by friction on the edges of steel plates, or from other cause, dangerous short circuits will result with possible damage to the workmen and the work.

Geared Hoists

In comparing pneumatic geared hoists with the electric hoists, disregarding the pneumatic direct-acting piston hoists owing to their excessive weight, it will be found, as in the case of drills, that the pneumatic hoists will consume more power than electric hoists of the same capacity and hoisting speed. Moreover, the pneumatic hoists at present available on the market cannot after a few weeks' service at maximum capacity maintain the load at a fixed height, the leakage causing the load gradually to descend, with the result that the hoist must be repaired and put in first class condition again.

On the other hand, electric hoists have none of these disadvantages, nor any of the others attributed to electric drills, so that, as a rule, electric hoists are preferable to pneumatic hoists in shipbuilding work.

Electric hoists are rarely overloaded, as the capacity of the hoist is usually rated considerably above the average load to be handled. They are also fitted on jibs or overhead traveling cranes, or on fixed beams at a considerable height above the ground or floor, so that the wires conveying the electric energy to the hoists are very unlikely to be damaged by contact with the material raised or with the supports. Electric hoists have the added advantage that they can be fitted with closed motors giving good protection from the effects of the sea air.

Conclusions

From the above it may be concluded that in shipyard practice pneumatic drills, although requiring more power, are preferable to electric drills because they are less easily damaged when overloaded or roughly handled, and because serious damage cannot result from injury to the flexible connections transmitting the power to the drills, as in the case of wires supplying the electric drills.

On the contrary, in the case of geared hoists, it will be found that electric hoists are preferable because they consume about one-fifth of the power required for pneumatic hoists, and, furthermore, they are easier to maintain and are more reliable.

Genoa, Italy. Adolfo Bassi.

Renewing Wornout Pump Linings

When pump linings become worn out, badly scored or deteriorated, new liners are almost always obtainable from the makers of the pump. Giving them the data of the pump, generally the serial number is sufficient. Some pumps have a spare liner on hand at the time of their installation. This is the best practice, for a spare furnished at the time of installation of the pump is generally a counterpart of the one in the pump and made by the same workmen. These hardly ever give any trouble fitting them, whereas one ordered some years later may have a small error in measurements and give a little trouble when it is installed.

Original liners that are placed in the pump by the makers are almost sure to be forced in by hydraulic pressure, therefore it is most likely that when it is to be taken out the quickest and easiest method will be to cut it out with a long diamond point or round nose chisel, although

the same method used in putting them in can be tried for taking them out if desired.

The following is the method used in our plant for renewing liners: After removing the old liner, the inside of the pump barrel is callipered and the measurements of this and the new liner checked up to see if any draw filing is necessary to enter the liner and that it is not too large for drawing in. A table of allowances for force and driving fits is given in "Kent's Mechanical Engineer's Pocket Book." For force fits to a 10-inch cylinder .010 is allowed, and for each one inch of increase in diameter of liner a little less than one-thousandth for forcing is allowed. For a 20-inch diameter there is allowed .017. Now, a *drive* fit is only one-half a forced fit.

The entering end of the liner is slightly chamfered to aid in easy starting. Then the outside of the liner is given a coat of grease, also the inside of the pump barrel. The

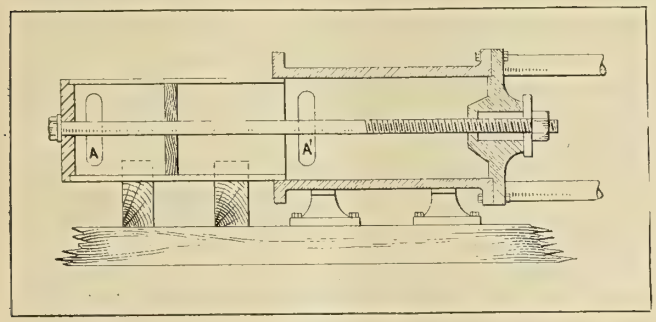


Fig. 1

liner is then placed in position as shown in Fig. 1 and entered as much as possible by hand.

There should be two blocks of wood sawed out half-circular to the outside diameter of the liner and of just the correct height to support the weight of the liner in line with the cylinder bore as shown. A circular piece of plank is cut to fit the inside of the liner, with a hole just the diameter of the long rod or bolt. This supports the weight of the rod.

A circular plate has to be made from heavy boiler plate to the sketch as shown, having a projection on the inside of the liner and just slightly smaller on its outside diameter than the liner, with a hole in the center for the rod. The bolt must be long enough to project through the stuffing box, and a heavy plate washer used under it as shown.

Now by screwing up on the nut the liner can be drawn home. A wrench must be used with long leverage, and one at the other end to prevent turning the rod. When starting the liner into the cylinder care must be taken, if there are any ports, to see that they are going to line up as *A* and *A'* in the sketch.

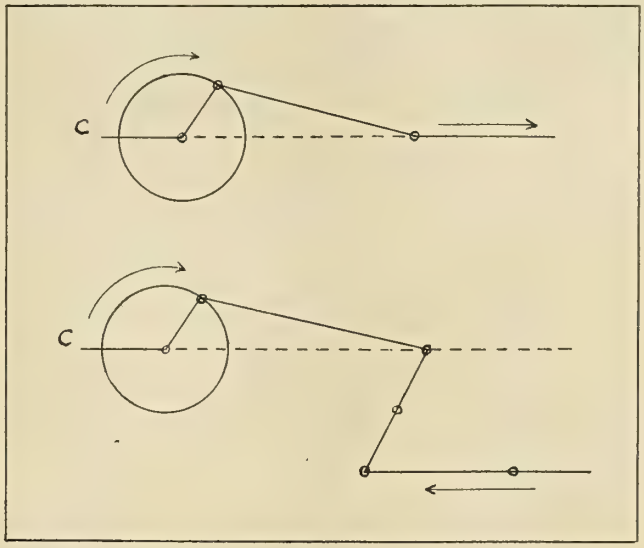
The diameter of the long rod or bolt should be the same diameter as the piston rod used on the pump. This just fits nicely in the stuffing box. It could be made in two parts with a coupling, using one section of piston rod and making the long, threaded part of a separate piece.

C. H. W.

New Giant Liner Ready.—The British Admiralty has handed over the steamship *Statendam,* which was purchased on the slips at Belfast from the Holland-America Line shortly after the beginning of the war, to the Cunard Steamship Company. She is being fitted out to carry freight between New York and Liverpool, and will be called the *Neuretania.* Cunard officials in Liverpool say the new steamship will have cargo space for 21,000 tons, the largest amount of freight ever shipped from America on a single vessel.

Direct and Indirect Valves

There appeared in the August number of Marine Engineering an inquiry pertaining to direct and indirect valves, and the explanation given, while generally accepted, is not in my opinion correct, for I hold that a direct valve may be either outside or inside, and likewise an indirect valve may be either outside or inside, depending upon the manner in which it is connected. For instance, where the valve stem is direct connected to the



Upper Diagram, Direct-Acting Valve; Lower Diagram, Indirect-Acting Valve

eccentric rod and is therefore under the direct influence of the eccentric and rod, the valve is said to be *"direct,"* but where the valve stem is worked through a *rocker arm* it is said to be *"indirect,"* as the accompanying sketch will show.

These arrangements give four combinations, as shown in the following table:

Valve	Connection	Angle Between Crank and Eccentric	Which Leads
Outside	Direct	$90 + \delta$	Eccentric Leads
Inside	Direct	$90 - \delta$	Crank leads
Outside	Rocker	$90 - \delta$	Crank Lead
Inside	Rocker	$90 + \delta$	Eccentric Leads

U. S. S. *New York.* James Kirvan, C. M. M.

Dredge Troubles

Some time ago the writer had occasion to visit a dredge that was operating in a fresh water river. The owner, a friend, stated that the output of the dredge was being handicapped by reason of the boiler priming constantly at heavy loads, and that he was positive that the priming was not due to the boiler being dirty, as it had been given a thorough overhaul during the previous month. To understand the case better, a description of the situation is necessary. The dredge was laying in a bight of the river, and the water, while dirty, was fresh. It was secured by the usual lines, and was free to rise and fall with the tide, with plenty of water under the bottom, a point which is well to note when securing a dredge. The silt for the suction was supplied by barges and the discharge lines were normal, so everything was quite usual. The boiler, of the Heine type, was situated in the after end of the dredge. The engine was set about twenty feet forward of the rear end of the boiler, thus giving a very short lead for the steam piping. Also it was noted that the engine throttle was on the same level, horizontal, as the top of the steam drum. Water was supplied to the

boiler by an injector, but the feed heater installed was not in use.

Having ascertained these points, I questioned the man who was in charge of the plant. From what information he was willing to supply, it was quite evident that the above-mentioned boiler trouble was chronic. Moreover, he stated that when the feed heater was in use the injector gave trouble, hence he did not use the heater.

One point was evident at once, the boiler was being handicapped, but this was not incidental to priming, and it may be added here that the Heine boiler is not subject to this disease if properly handled. The feed water, while not being such as any self-respecting boiler would receive of its own volition, was not so bad as to cause excessive priming at the rate of steaming demanded of the boiler. Examination showed that the strainer was of the old-fashioned basket type and sadly in need of cleaning. A modern strainer with periodic cleanings was recommended for this. The injector trouble was simply a combination of the strainer conditions and having the feed water too hot. Nearly every engineer knows, or at least should know, that the temperature of the feed water radically affects the action of an injector, and that a set of curves should be obtained with the injector, either from the builder or elsewhere, one of these curves having been obtained by making a series of runs with steam and discharge pressures adjusted as for ordinary operation, average lift and suction, and varying the temperature of the suction water, starting at a low temperature and gradually increasing the temperature of the suction water until the injector "breaks"—refuses to operate. In the case under observation it was very evident that this knowledge was lacking on the part of the man in charge, and that his feed water was too hot. So all that was needed here was a little adjustment of the feed heater.

Having mentioned these, let us say, minor troubles, we will return to the main cause of contention—the excessive priming of the boiler. From the facts so far ascertained, it was quite evident that the trouble was either in the steam piping or in the setting of the boiler itself. The water in the boiler was being carried at a normal level, about one and one-half gages at the time and everything was going satisfactorily. For a time the proposition looked like a real problem, but a short conversation with the fireman brought to light the fact that at high rates of steaming he considered it essential to safety to carry at least a half glass of water. Other things being equal, this should not have caused such havoc, but it did give a hunch, and that hunch was to examine the setting of the boiler as regards the height of the front of the drums relative to the height of the rear.

There was nothing more to it. A few measurements showed that the rear end of the drums was some inches below normal position. This was caused by improper lining up in the original installation or by a drop in the foundation, the latter being the most probable. However, such was the case, and should have been discovered when the dredge was purchased. It was now too late to rectify it except at excessive cost, as the dredge was working on contract. The substance of the case was that the dredge was a bad bargain. However, the case was not entirely hopeless, as will be seen later.

To understand the effect that the setting had on the priming it is first necessary to consider how moisture gets into the steam. Consider a bubble of steam rising up through the water, when it reaches the surface it must break through the surface film. As the surface tension is overcome there is a small explosion and the film is shattered, with the result that minute particles of water are scattered in all directions. These minute particles are picked up by the outflowing steam current and carried along into the steam pipe. It is quite evident that the greater the amount of steam generated, the greater the number of explosions, hence at high capacities there will be more minute particles of water being scattered in all directions. Furthermore, if the disengaging area be in any way reduced, the agitation will increase and at the same time the exit velocity of the escaping steam will increase. Hence it is proper to assume that a greater amount of moisture will be picked up and carried into the steam line by the outrushing steam. In other words, the amount of moisture entailed will depend on two things: first, the cubic feet of steam escaping; second, the area of the surface through which it escapes; the one divided by the other giving the mean exit velocity.

In the case of the boiler in question it was safe to assume the velocity of the water circulating in the tubes to be about sixty feet per minute and the cross-sectional area of the tubes to be about seven square feet. That is, in one second there would be discharged to the water leg seven cubic feet of water. Now if the area of the water passage from the leg to the drum is two square feet, the velocity will be in the vicinity of three feet per second. And considering that this water is now in the form of steam, it is safe to assume the velocity to be nearly doubled, with the result that the water level may be lifted several inches. Naturally there will be a violent surface agitation with a big percentage of moisture kicked up, more or less of which is bound to be picked up by the outflowing steam.

If the above conditions exist normally, what must be the conditions when the disengaging area is reduced by one-half or one-third? Such, however, was the case here. When the water glass showed half full, the water was close up to the top of the drum in the rear and the designed steam space and disengaging area were reduced by fully thirty percent, the result being that a great amount of moisture was whirled upward into the short steam line take-off and from there led directly to the engine throttle. To change the setting, as mentioned before, was out of the question. But it was possible to make four improvements: first, feed cleaner water; second, feed hot water to the boiler; third, carry the water at a lower level in the boiler; fourth, make a simple change in the discharge steam piping, this latter being in the form of a small steam drum to counteract the reduced steam space in the drums proper. The discharge pipes from the drums were very short and connected by a pipe of nearly the same diameter. As can be seen, the idea was to increase the length and the diameter of this pipe so that it would have a fairly large capacity, and thus allow time for the entailed moisture to be thrown down. From latest reports everything has been going satisfactorily.

Having never before had the opportunity to visit a dredge, the situation was much more interesting than it would have been otherwise, and it is believed that the points brought out above will be of interest to anyone in the dredge business, as they are general in nature, and it seems to me quite likely to be prevalent, owing to the peculiar conditions under which dredges are operated.

D.

LAKE SEAMEN'S WAGES RAISED.—At a meeting of the board of directors of the Lake Carriers' Association in Cleveland, August 3, all Lake seamen below licensed officers were granted a raise of $10 per month in wages for the period from August 1 to October 1. The directors recommended that the question of additional remuneration for licensed officers be taken up at a later meeting of the vessel owners.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, and defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Marine Reduction Gears

Q.—Do all marine reduction gears make use of a flexible connection between the driving pinion and the driven gear, such as the so-called "floating frame" of the Melville-McAlpine gear? M. C.

A.—No. The Parsons and De Laval systems adopt rigid connections, using fixed invariable bearings for both pinion and gear.

Weight of Aeroplane and Automobile Engines

Q.—Can you give me approximately the weight per brake horsepower of aeroplane and automobile engines? A. E.

A.—For engines complete, including flywheel, automobile engines range from 12-17 pounds per brake horsepower, and aeroplane engines range from 3-5 pounds per brake horsepower.

Temperature of an Air Pump Discharge

Q.—We carry customarily a vacuum of 26 inches. Will you please tell me the best temperature to have the air pump discharge? P. M.

A.—One hundred and ten degrees Fahrenheit is a good temperature. In general, from 10 degrees to 20 degrees below the temperature of saturated steam at the pressure of the vacuum is a good rule.

Size of Searchlight

Q.—About what size searchlight should I put on a 300-foot tramp freighter? What determines the selection of size? J. P. CALL.

A.—An 18-inch diameter unit would probably be satisfactory. There is no rule for determining a proper size, as it is a function of route and duty of the ship and her electrical equipment. In a ship of moderate dimensions there is usually ample power available for an 18-inch light and it is unwise to go much below this size.

Method for Finding Power of a Number

Q.—Will you please show me how to get the 2.83d power of a number? In the expression for net horsepower the speed comes in as $V^{2.83}$ and I am not sure that my method of obtaining it is correct. M. A. T.

A.—Let it be required to find $(14.27)^{2.83}$:

$$\text{Log } (14.27)^{2.83} = 2.83 \times \text{log of } 14.87 = 1.1723 \times 2.83 = 3.3176$$

(Number corresponding = 2078.)

It is easier to carry out the entire computation by logs, in which case

$$\text{Log log } (14.27)^{2.83} = \text{log } (2.83 \times \text{log } 14.87) = \text{log } 2.83 + \text{log log } 14.87 =$$

$$\text{Log } 14.87 = 1.1723$$

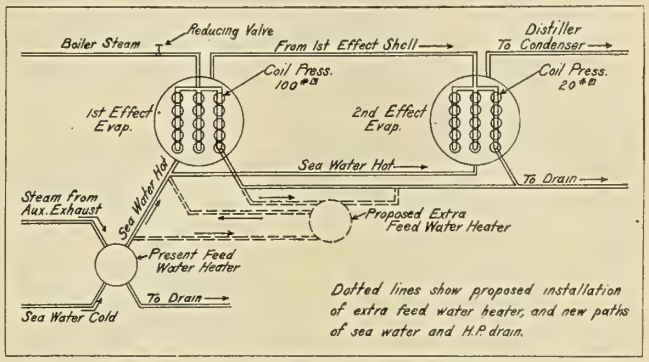
$$\text{Log log } 14.87 = 0.0690$$
$$\text{Log } 2.83 = .4518$$
$$\text{Log log } (14.27)^{2.83} = .5208$$
$$\text{Log } (14.27)^{2.83} = 3.3176$$
$$(14.27)^{2.83} = 2078$$

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

Feed Heater for Evaporator Plant

Q.—We have two Reilly multicoil evaporators operated in series which have a total capacity of about 12,000 gallons per twenty-four hours. We operate usually on live steam at about 100 pounds gage in the first effect or high pressure coils and about 20 pounds gage in the second effect coils. The water fed to the evaporators passes through a feed water heater before entering and all the steam made by the evaporation passes direct to the distiller, where it is condensed into water. The feed heater operates on steam from the low pressure coils (about 20 pounds gage). It is proposed to increase the temperature of the sea water fed to the evaporators by installing an additional feed heater which is to derive its heat from the drains from the high pressure coils. Do you think this is feasible, and would you expect any gain in the amount of water produced, if it is put in? I inclose a diagrammatic sketch of the plant as it now is and as proposed. F. W. H.

A.—The scheme proposed will work well and should give an appreciable increase in capacity. It has actually been used and in one case when tests were made before and after the installation of this secondary feed heater in a plant very similar to that described a gain of about 23 percent in capacity was realized when the feed for both effects was sent through it. There is also undoubtedly



Arrangement of Evaporator Plant

some gain in efficiency, or pounds of water produced per pound of coal, as in the present condition you are returning water (the drain from the high pressure coils) at the very high temperature corresponding to 100 pounds pressure to the hot well with a considerable loss of heat on the way. The gain in *capacity* is not to be considered as an indication of a corresponding gain in *efficiency*, as the latter is much less.

Test of Steam Pump

Q.—I have on this ship two large reserve feed tanks and I plan to use one as a condenser and meter for a short test run on a steam pump that I have been altering. I plan to note the temperature rise after discharging the pump exhaust into the feed tank for about twenty minutes, multiply this by the pounds of water in the tank, and use this as the heat taken from the steam. If I know the heat per pound in the exhaust steam, which I can get from steam tables, I figure that the heat taken up by the tank, divided by the heat in one pound of the steam, will give me the number of pounds of steam condensed. Will you please tell me if my method is correct and suggest any points that need most careful attention? S. P.

A.—If the tank capacity is large and is accurately known, the method is approximately correct. You should, however, divide the product of the temperature rise and pounds of water by the heat contents of the exhaust steam *minus* the *heat contents* of the *condensate* (or heat of the liquid, which is nearly the final temperature in the tank, less 32 degrees) and *not* by the *total heat contents* of the exhaust steam. The quality of the steam at exhaust from the pump will have to be determined by a calorimeter and allowance should be made for the aug-

mentation of volume of the water in the reserve feed tank, due to the rise in temperature. (From 40 degrees F. to 140 degrees F. the increase in specific volume is 3/160 by Marks & Davis' Steam Tables.) The tank itself should, of course, be accurately calibrated and the vessel must be on an even keel and without list.

Electric Wiring

Q.—For electric lighting and general wiring on shipboard, is it necessary to run the wires in conduits? E. W.

A.—Conduits have been largely used for electric wiring aboard ship, but the most approved present practice is to dispense with them and use heavily rubber insulated leads not inclosed. When conduits are used there seems to be a tendency for moisture to accumulate in them, and the deterioration of the insulation is more rapid than when not inclosed.

Ahead and Backing Power of Engine

Q.—Can you tell me if the power of an engine is the same for the same boiler pressure and revolutions per minute when backing and when going ahead? I hold that it will be the same or even more, because the propeller is probably less efficient when backing. The chief says it is less and says that the backing crosshead guides are given less area for that very reason. It seems to me, though, that other things might have regulated that, such as length of time engine will be reversed, etc. A reply through your columns will be greatly appreciated. B. A.

A.—Considering the propeller alone, it has been found that for the same revolutions per minute and slip the power required to turn it reversed is roughly three-fourths of the power to turn it ahead. There are few full speed trials astern available for information as to power when the propeller is operating with the hull, but a recent trial of a high-powered twin screw vessel full speed astern gave an indicated horsepower of 84 percent of the go-ahead power at the same revolutions per minute. The cards were taken after the ship had gathered sternway and give reliable information. The power which a propeller requires varies with the slip, and with the ship under less sternway the same revolutions per minute might require somewhat greater power than above, but it would not be for a long interval of time. The backing guides of an engine are commonly made three-fourths of the area of the go-ahead guides for the above reason, and also as the time in reverse is rarely long.

New Books for Marine Engineers

THE NAVAL ARCHITECT'S, SHIPBUILDER'S AND MARINE ENGINEER'S POCKET-BOOK. Eleventh edition. By Clement Mackrow and Lloyd Woollard. Size, 4 by 6½ inches. Pages, 742. Illustrations, 264. London, 1916: Crosby Lockwood & Son. Price, 12/6 net.

This book, which has long been before naval architects and shipbuilders as a convenient reference book of formulæ, rules and tables, has been thoroughly revised and in many sections considerably extended to include recent data from modern practice in shipbuilding. Among the new sections inserted is one on speed and horsepower of ships which it is believed will be useful in enabling ships of ordinary form to be approximately powered from the data given. The necessity for economizing weight where possible without diminution of strength has led to the sections on strength of materials, riveted joints and stresses in ships being considerably extended. Information regarding British standard sections, screws, keys, etc., has also been added by permission of the Engineering Standards Committee. Finally, two new sections, one on aerodynamics and the other on aeronautics, have been added in view of the increasing importance of the recent development of aeronautics. The book is excellently arranged, but in common with the previous editions lacks the completeness that should be found in a naval architect's handbook.

MECHANICAL ENGINEERS' HANDBOOK. Edited by Prof. Lionel S. Marks. Size, 4⅝ by 7¼ inches. Pages, 1,836. Numerous illustrations. New York, 1916: McGraw-Hill Book Company. Price, $5.

This handbook, while based on the Hütte, represents the work of fifty eminent specialists in various branches of mechanical engineering and is intended to supply both the practicing engineer and the student with authoritative data covering the field of mechanical engineering in a comprehensive manner and in such form as to be immediately available for ready reference. While many of the sections of the book follow the Hütte closely, with the addition or substitution of American engineering data, nevertheless the greater part of the book, particularly those portions which deal with engineering practice, is new. In all there are fifteen separate sections in the book, listed as follows: Mathematical tables and weights and measures, mathematics, mechanics of solids and liquids, heat, strength of materials, materials of engineering, machine elements, power generation, hoisting and conveying, transportation, building construction and equipment, machine shop practice, pumps and compressors, electrical engineering, and finally engineering measurements, mechanical refrigeration, etc. A portion of the section on transportation is devoted to marine engineering, and this material is contributed by Dr. W. F. Durand, formerly advisory editor of this journal.

At the beginning of each section is a title page giving a table of contents for the section, while at the end of the book is a very complete alphabetical index comprising 56 pages covering the entire contents of the book. The book as a whole will be found a valuable aid to engineers, both on account of the authoritative data which it contains and the comprehensive and convenient manner in which it covers the field it is intended to serve.

Naval Architects' Annual Meeting

The twenty-fourth annual meeting of the Society of Naval Architects and Marine Engineers will be held on Thursday and Friday, November 16 and 17, at the Engineering Societies building, 29 West Thirty-ninth street, New York. The professional sessions will be followed by an annual banquet at the Waldorf-Astoria Hotel on Friday evening, November 17.

The following is a preliminary list of papers which have been promised for presentation at the meeting:

"Alquist Gearing for Ship Propulsion." By W. L. R. Emmet.

"Electric Cargo Pumps." By Hugo P. Frear.

"The Design of an Oil Engine." By John F. Wentworth.

"Aeronautics in Relation to Naval Architecture." By Naval Constructor H. C. Richardson, U. S. N.

"New Method Indicating the Density of Smoke as Installed on the U. S. S. *Conyngham*." By Rear Admiral R. T. Hall, U. S. N.

"Classification of Ships." By Norman E. McClelland.

"Maintaining a Navigable Channel by Revettment." By Parker H. Kemble.

"Dry Docks and Marine Railways." By Rear Admiral R. T. Harris, U. S. N.

"Dredging Equipment Used in the Panama Canal." By George B. Ward.

"Salvage Gear Used in Raising the *F*-4." By Naval Constructor J. A. Furer, U. S. N.

"Certain Tests of Ship Brakes." By John H. Hyde.

"Theory of Fluid Friction." By W. Gatewood.

"The Resistance of Various Types of Barges in Shallow and Deep Water." By Professor H. C. Sadler.

"Feathering Paddle Wheels." By Prof. E. M. Bragg.

"Model Basin Tests." By Naval Constructor Wm. McEntee, U. S. N.

"Shop Management." By Naval Constructor T. G. Roberts, U. S. N.

"Naval Stations and Naval Bases." By Captain A. P. Niblack, U. S. N.

"Power Process of Forging Heavy Chain Cable." By Naval Constructor F. G. Coburn, U. S. N.

Shipbuilding and General Marine News

Contracts for New Ships—Marine Terminal Improvements—Recent Launchings—Improved Appliances—Personal Items

Contracts for 20,000 tons of marine plate have been placed recently by shipbuilders on the Atlantic coast. In addition to this, 12,000 tons of steel ship plates have been sold for export, and negotiations are now being made for 10,000 to 15,000 tons more for domestic and foreign shipping. The principal buyers during the month were the Pennsylvania Shipbuilding Company, Gloucester, N. J., which is understood to have placed orders for 12,000 tons of marine plate for the construction of five vessels; The Standard Shipbuilding Company, which has placed orders for forgings for five vessels of from 5,000 to 8,000 tons deadweight capacity and for 8,000 to 10,000 tons of plate; and the Sun Shipbuilding Company, which has placed orders for 8,000 tons of plate for the construction of tank steamers for delivery in the first quarter of 1917. The export orders came from Italy and Japan.

Shipbuilding Contracts

It is reported from South Bethlehem, Pa., that the Bethlehem Steel Company, which recently acquired the Maryland Steel Company, Sparrows Point, Md., will make large additions to cost more than $30,000,000, and has placed an order to build five ore-carrying vessels of approximately 17,000 tons capacity each, to be built by the Maryland Steel Company. These vessels, so it is stated, will fly the American flag and will be operated by the Ore Steamship Corporation, a subsidiary of the Bethlehem Steel Company.

The Skinner & Eddy Corporation, Seattle, Wash., has received an order to build three more steamships for delivery during the last part of 1917.

J. Murray Watts, naval architect, Philadelphia, Pa., has designed two steamships for the United States & Ecuador Steamship Company, Philadelphia, Pa.; a four-masted barkentine for the American Tie & Timber Company, Savannah, Ga.; a 95-foot tug for the Poitevant & Fabre Lumber Company, Mandeville, La., and two steel motor barges for the Macon-Atlantic Transportation Company, Macon, Ga.

The Herreshof Manufacturing Company, Bristol, R. I., has received an order from J. P. Morgan, New York, to build a high-speed power yacht 100 feet over all.

The Oregon-Alaska Steamship Company, Portland, Ore., will, so it is stated, soon place an order for a freight and passenger vessel.

The John Wilson Shipyard, Seattle, Wash., has received a contract to build a motor freight boat, 80 feet long, from plans by F. A. Ballin, naval architect, Portland, Ore.

The Nova Scotia Steel & Coal Company, New Glasgow, N. S., will build a 300-foot freight steamship.

Rice Bros. Company, East Boothbay, Me., will build Light Vessel No. 99 at a cost of $61,000 for the Bureau of Lighthouses, Washington, D. C.

The China-American Motor Ship Company has been incorporated by Melbourne Crisp and L. McDonough, San Francisco, and L. A. Hewitt, of Oakland, Cal., to build five ships for service between Hong Kong and Vladivostock, with San Francisco as a home port. According to report these vessels will be of 2,000 gross tons, 256 feet long each, and will be equipped with oil engines.

The Pusey & Jones Company, Wilmington, Del., has received contracts to build eight more vessels for Norwegian interests, each about 300 feet long.

The Union Iron Works, San Francisco, Cal., has received contracts to build four steel shelter deck freight ships, each of which is to be 410 feet long. Two of these ships will be equipped with Curtis turbines.

The newly-organized American Shipbuilding Company, Astoria, Ore., a branch of the American Shipbuilding Company, of Cleveland, Ohio, has secured a contract to build a 315-foot wooden lumber schooner.

The Union Iron Works, San Francisco, Cal., has a contract from the Crowley Launch & Towboat Company, San Francisco, Cal., to build a 180-foot steel barge.

The Wallace Shipyards, Vancouver, B. C., have received a contract from H. W. Brown & Company, Montreal, Can., to build three wooden lumber schooners to be equipped with oil engines.

A London firm is reported to have placed an order for the construction of a steel steamer at North Vancouver, B. C. The steamer will be 315 feet long, 45 feet beam, with a carrying capacity of 5,000 tons and a speed of 9½ knots.

The Albina Engine & Machine Company, Portland, Ore., has taken a contract for repairs to the steamer *Kenyon Maru* amounting to about $235,000.

Robert Jacob, City Island, N. Y., was the lowest bidder for the United States coast guard cutter *No. 29*, which is to be 67 feet long and to have a speed of 18 miles per hour. Propulsion will be by two eight-cylinder gasoline engines, capable of developing 800 horsepower.

The Townsend Marine Railway & Construction Company, of Boothbay, Me., has received a contract from Crowell & Thurlow, of Boston, Mass., for a four-masted wooden schooner 200 feet long.

The Lehigh Valley Railroad has recently let contracts for a steel steam lighter with a capacity of 582 tons, one 23-car capacity steel car float and two 12-car capacity steel car floats, ten grain boats, each of 1,000 tons capacity, and six 90-foot covered barges for the transportation of general merchandise. This equipment is for the railroad's service in New York harbor, and is in addition to the orders placed a short time ago by the company for a tug, seven car floats, ten barges and an assortment of gasoline hoists, lighters and scows.

Shipyard News

The Elliott Bay Ship & Engine Company, Seattle, Wash., has purchased a 9-acre site on which a shipbuilding plant is to be erected. The president of the company, C. O. Morrow, states that he has already received sufficient orders to keep the plant busy for a year.

W. H. Curtis, Portland, Ore., writes MARINE ENGINEERING that he is starting a wooden shipbuilding plant and desires to get in touch with brokers or owners desiring vessels built.

The Delaware Shipbuilding & Engineering Corporation has been organized and has purchased a tract of 11 acres at New Castle, Del., where it will build a shipyard. At the beginning the company will confine its attention to the construction of wooden and steel vessels of the smaller type, running up to 300 feet in length. They will be similar to the ships used on inland waterways in Norway and Sweden. The plant will be in charge of an expert engineer from the lake district, who has also had extensive experience in Europe. As soon as possible arrangements will be made for constructing large vessels. The site has a frontage of 600 feet directly on the river and is considered an ideal place for a shipyard.

The North Pacific Shipbuilding Company has been incorporated and is planning to establish a shipbuilding plant at Portland, Ore., to operate in conjunction with the Smith & Watson Iron Works and the Northwestern Steel Works, of Portland, where the machinery for vessels built will be constructed.

It is reported from Portland, Ore., that a new shipbuilding company has been organized under the name of the Standifer-Clarkson Shipbuilding Company.

J. D. Barnes is president of the new company, which, it is reported, will build a shipbuilding plant in Alameda, Cal. It is also reported that this company has already received contracts to build two freight ships.

The Peninsular Shipbuilding Company has been organized at Portland, Ore., and will build wooden ships.

It is announced that the old Palmer shipyard at Noank, Conn., will be greatly enlarged and that the new owners will build six four-masted schooners. Captain Frank Meader is manager.

F. S. Pendleton states that he will build a ship repairing plant at Mystic, Conn.

The Samuel L. Moore Sons Corporation, Elizabeth, N. J., has had plans completed for carpenter shop, power house and office building, 50 by 75 feet, two stories, and 60 by 140 feet, one story. The architect and engineer, the Ring, Cleaves, Graham Company, 280 North Broad street, Elizabeth, is about to take bids.

D. E. Skinner, president of the Skinner & Eddy Corporation, Seattle, Wash., states that the company has sufficient work on hand to run at full capacity for more than two years. It has contracts to build ten ocean-going steamships to cost between $750,000 and $1,000,000 each.

The plant of the Great Lakes Engineering Works at St. Clair, Mich., has been bought by Pope Bros. & Cheppu Company, Ltd. It is reported that the property has been secured for the Canadian government, which, it is also reported, plans to take over the shipbuilding yards of the C. C. Smith Boat & Engine Works, Algonac, Mich., and the S. C. McLoud Shipbuilding plant at Marine City, Mich.

A contract has been let to J. A. Maceachern for driving piling for the ways of a new shipyard to be established near Astoria by the American Shipbuilding Company. The company is capitalized at $1,500,000, and it is reported that contracts for the construction of seven auxiliary schooners with a capacity of 2,250,000 feet of lumber have been secured from Hind, Rolph & Company, of San Francisco.

The plant of the California Shipbuilding Company at Long Beach, Cal., is now working with a full force of men that have taken every place vacated by the strikers. Open-shop conditions strictly prevail at the plant, and will continue to do so, according to the officials of the yards. The launching of two submarines now ready, with the exception of part of the machinery, was postponed until the last of August, because of the delay in the shipment of the machinery from the East. The laying of the keels of the new submarines to be built is also being held up on account of the failure of a shipment of steel to arrive on schedule time.

The Quebec Shipbuilding & Repair Company, Ltd., Montreal, has been incorporated, with a capital stock of $40,000, by Walter R. L. Shanks, Francis G. Bush, George R. Drennan and others to build ships, torpedo boats, etc.

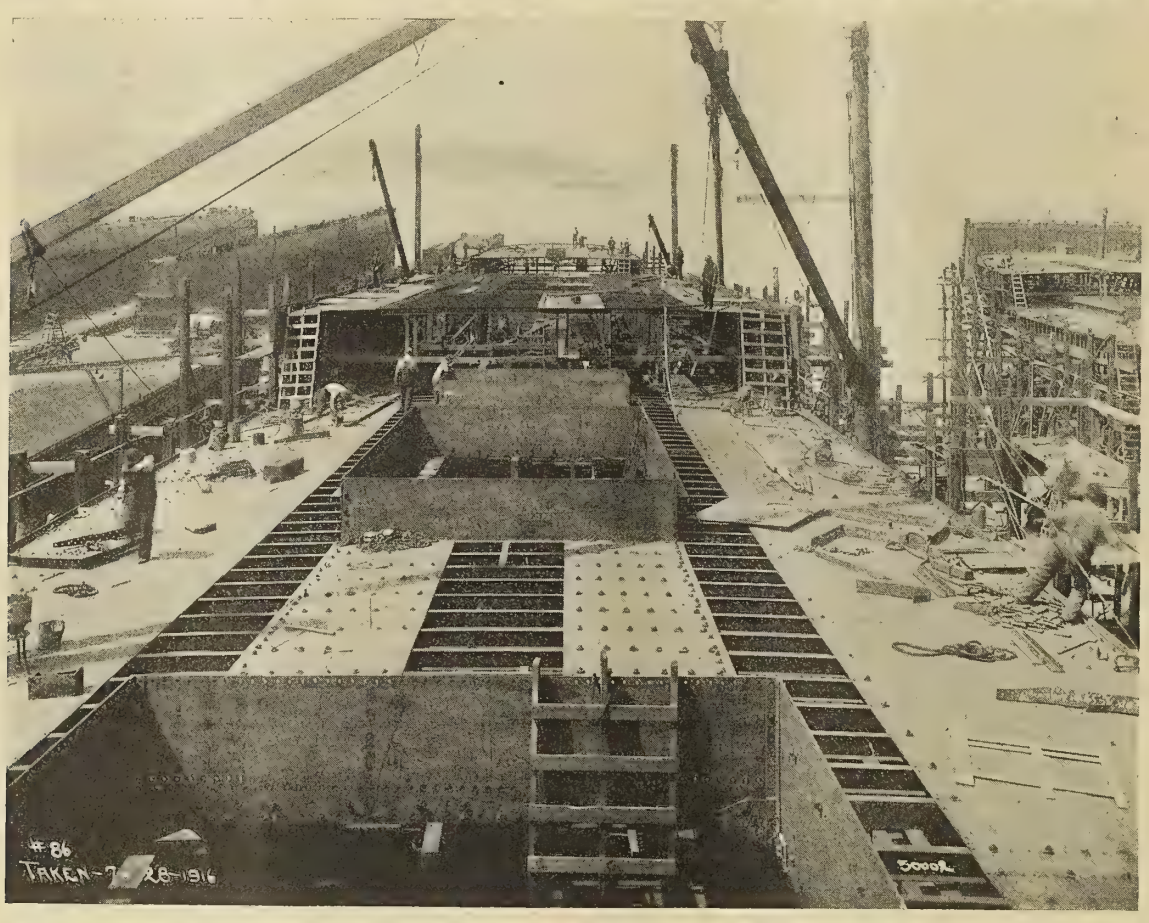
As showing the movement under way for expansion of the shipbuilding and drydock industries of the South, it is of interest to note that from New Orleans and Pensacola come announcements this week of new companies organized for undertakings in these lines. At New Orleans the Pan-American Shipbuilding & Salvage Company has been organized, with a capitalization of $1,000,000. The company proposes to install ways for four wooden ships, with complete facilities for repairing and constructing vessels. It will also equip a salvage outfit with seagoing tug, the company having acquired, according to reports, the exclusive rights in American waters for a simple and practical system of salvaging which reduces salvage costs one-quarter and the time to days instead of weeks and months, as in the old pontoon and lift systems.

On the Levis, or south shore, of the St. Lawrence, at the entrance of Quebec harbor, a new drydock, costing $3,000,000, has been under construction for more than a year.

The American Shipbuilding Company, Spokane, Wash., has already begun laying the foundation for its shipbuilding plant at Young's Bay on the Columbia River. It is planned to build at this yard five wooden schooners for the lumber trade before the end of the year.

Seattle Shipyard Under New Control

With the recent transfer of the controlling interest in the Seattle Construction & Dry Dock Company, Seattle, Wash., to the Todd Ship Yards Corporation of New York, J. V. Patterson, president of the Seattle concern for the past ten years, resigned, and his place has been filled by C. W. Wiley, marine superintendent of the Great Northern Steamship Company.



Progress of Work on July 28 on Ward Liner under Construction at the Yards of the Seattle Construction & Dry Dock Company

The new board of directors will consist of William H. Todd, of New York, president; C. W. Wiley, of Seattle, vice-president and general manager; H. W. Kent, of Seattle, secretary and treasurer; H. F. Alexander, W. H. Bogle, E. C. Ward and F. T. Merrit, of Seattle, and R. S. Walcott, of New York.

Mr. Alexander is president of the Pacific Alaska Navigation Company, W. H. Bogle and F. T. Merrit are attorneys, and E. C. Ward is vice-president of the Pacific Coast Steamship Company. C. W. Wiley is a graduate of the Massachusetts Institute of Technology and came to Seattle about sixteen years ago as marine superintendent of the Boston Steamship Company and Boston Towboat Company, which operated the Shawmut, Tremont, Hyades, Pliades and Lyra in the Seattle-Orient trade.



Plate Storage Area in Skinner & Eddy Shipyard, Seattle, Wash., Showing Yard Cranes

The Todd Shipbuilding Corporation also controls the Robins Dry Dock & Repair Company, Erie Basin, Brooklyn, N. Y., and the Tietjen & Lang Dry Dock Company, Hoboken, N. J. Two new building slips are being constructed by the new concern and a 15,000-ton floating dry dock will be added to the three dry docks now in operation. Work on the new dry dock will begin at once. The yard has all of the new construction it can handle with its present capacity and all the repair work the shops can accommodate.

Progress of Work at the Skinner & Eddy Yard

The Skinner & Eddy Corporation, Seattle, Wash., has taken contracts for eight steel freighters and tank steamers and is figuring on two more. Two of these vessels are on the ways and the keel for the third will be laid in a few weeks. The driving of the piles of the ways for the third vessel has just been finished and the superstructure and planking are being added.

New shops are being built to take care of the additional work and everything is being done to handle the work as fast as possible. This yard is not a year old, but it is showing all of the energies and efficiency of an established concern.

The two steel freighters now on the ways are 423 feet 9 inches long overall, 410 feet between perpendiculars, 54 feet molded beam, 29 feet 9 inches molded depth, 24 feet loaded draft, 8,800 tons deadweight, and will have a sea speed of 10½ knots. They will be single screw of the poop, bridge and forecastle type, with the machinery amidships.

There will be two steel masts with four 5-ton and one 30-ton cargo boom on each mast, and two derrick posts each fitted with one 3-ton cargo boom. There will be four large and one small cargo hatch through the upper and second decks. Wide spaced hold pillars will be fitted, arranged so as not to interfere with the rapid stowage and discharging of cargo.

The propelling machinery will consist of one set of Curtis turbines, with reversing turbine in the same casing, connected to the propeller shaft by a two-stage reduction gear. There will be three Scotch marine boilers fitted with superheaters and arrangements will be made to use either coal or oil fuel.

The two tankers, the keel of one of which is soon to be laid, have been sold to the Standard Oil Company. They are to be built under the Isherwood patents and are 433 feet 6 inches long overall, 420 feet between perpendiculars, 57 feet beam molded, 31 feet 6 inches molded depth, 25 feet loaded draft, 9,500 tons deadweight, and will have a sea speed of 10½ knots.

The hold will be divided into tanks for carrying oil in bulk, and the machinery, which is the same as for the freighters described above, will be located aft. A double bottom will be built under the machinery space and used for reserve feed water.

A tank about 10 feet deep will be built in the fore hold for fuel oil, or water ballast. The fore and after peak tanks will be used for trimming tanks. The vessels will be constructed with a straight stem, elliptical stern and with two continuous decks. They will have a raised forecastle, short bridge house amidships and full poop aft.

Electric Propelling Machinery for the United States Battleship Tennessee

The contract for furnishing the necessary equipment for the electric propulsion of the U. S. S. *Tennessee,* now under construction, has been awarded to the Westinghouse Electric & Manufacturing Company, of East Pittsburg, Pa. The system of propulsion being installed differs from any now in use by battleships. Two steam turbines, developing over 33,000 horsepower, will drive electric generators, which furnish current to four 6,700-horsepower motors, each motor driving a propeller.

In addition to the the main generating equipment and propelling motors, the contract includes the auxiliaries for the main turbine generator sets and smaller auxiliary turbine generators supplying light and power throughout the ship. The *Tennessee* will have several hundred electric motors for doing nearly all the work on board, from raising the anchor to steering. Electricity will also be used for cooking, ice making, refrigeration, and numerous other sundry purposes. In all about 37,500 horsepower of electricity will be needed, the amount required for a city of about 100,000 inhabitants.

A new shipyard has been established at Yokohama, capitalized at 3,750,000 yen, of which 937,500 yen has been paid up. The yard will be opened in November and orders for six vessels have already been secured.

A Vast Motor Ship Industry

Few shipowners are aware of the large number of our mercantile ships that are equipped with Werkspoor four-cycle type Diesel engines, and that only one other firm has a greater tonnage of ocean-going, oil-driven craft to their credit, and that particular concern's yard is entirely devoted to the construction of motor ships, whereas Werkspoor only have been able to devote part of their extensive works to this class of vessel.

They have been building stationary Diesel engines in large numbers for nearly seventeen years, and marine Diesel engines for nearly seven years. The following is a list of the ships (naval craft excluded) in actual service that are fitted with Werkspoor motors. The *Sebastian* was recently converted from two-cycle Diesel power of other make to Werkspoor four-cycle.

Name and Owners	Deadweight Capacity Tons	Indicated Horsepower Tons
San Antonio, A. Hammerstein	500	215
Cornelius, J. Van Rompu	600	265
Vulcanus, Anglo-Saxon Pet. Co.	1,900	500
Sembilan, Royal Packet Co.	300	265
Juno, Anglo-Saxon Pet. Co.	2,675	1,360
Emanuel Noble, Royal Shell Interests	6,500	2,750
Loudon, Royal Packet Co.	1,750	1,360
Artemis, Anglo-Saxon Pet. Co.	5,050	2,300
Ares, Anglo-Saxon Pet. Co.	5,050	2,300
Selene, Anglo-Saxon Pet. Co.	5,050	2,300
Hermes, Anglo-Saxon Pet. Co.	5,050	2,300
*Motrocine, Soc. Napthes Trans.	5,200	1,700
Elbruz, Royal Shell Interests	6,500	2,750
Jules Henry, A. Vimont	2,000	1,360
Poseidon, Anglo-Saxon Pet. Co.	800	450
Myer (Mijer), Royal Packet Co.	1,750	1,360
Siberg, Royal Packet Co.	1,750	1,360
Utrecht, Anglo-Saxon Pet. Co.	1,500	800
Lara, Anglo-Saxon Pet. Co.	875	650
Bengkalis, Royal Packet Co.	900	650
Boelongan, Royal Packet Co.	900	650
Sebastian, Lane & McAndrew	5,050	2,300
No. 17, Dutch Colonies Government	1,000	900
No. 22, Dutch Colonies Government	1,000	900
Totals	63,650	30,745

* The *Motrocine* was engined by a Werkspoor licensee.

It will be seen that altogether there are 24 Werkspoor Diesel engined ships in service, but many more are on order; in fact, their works at Amsterdam are overflowing with various orders. With auxiliary motors, the above engines must represent a turnover of over $2,000,000—this, of course, not including the ships and fittings—which will indicate how vast a business the marine oil engine is to this firm alone.

Recent Launchings

The schooner *James. M. W. Hall,* building at the Bowkers yard, Phippsburg, Me., for Rogers & Webb, of Boston, was launched on August 15.

The steam schooner *Stanwood,* 225 feet long, with a cargo capacity of 1,250,000 feet of lumber, was launched on July 15 at the Kruse & Bangs shipyard, North Bend, Coos Bay, Ore., for Bigsby & Clark, San Francisco, Cal.

The first launching at Aberdeen, Wash., in more than eight years took place on July 31, when the steamer *Oregon,* now building at the Peterson yard for Wilson Bros. & Company, of San Franciso, was launched. The vessel is 200 feet long, 48 feet beam, and 14 feet 8 inches depth, with a capacity for carrying 1,200,000 feet of lumber. The vessel was launched within five months after laying the keel, and is the first of two sister ships being built for the same company.

The Bath Iron Works, Bath, Me., launched on July 31 a 12-car capacity steel car float for the New York Central & Hudson River Railroad.

The steamer *Cormelia,* under construction for the A. H. Bull Steamship Company, New York, was launched at the Bethlehem Steel Company's yard at Sparrows Point, Md., on August 3. The vessel is 328 feet 6 inches long, 46 feet 6 inches beam and 25 feet 6 inches depth of hold, with a carrying capacity of 5,000 tons. She is the first vessel to be launched at this yard since the plant was taken over by the Bethlehem Steel Company.

The auxiliary tanker *Twilight,* building at Toledo, Ohio, for the Standard Oil Company of New Jersey, was launched on July 29.

The United States torpedo boat destroyer *Davis* was launched from the yard of the Bath Iron Works, Bath, Me., on August 15.

The first launching at the yard of the Chester Shipbuilding Company, Chester, Pa., took place on August 26. The vessel is an oil tanker of 8,000 tons deadweight, building for a Norwegian firm and will be known as the *Malmanga.* The length is 401 feet, the beam 54 feet and the depth 32 feet.

The steel barge *Dr. Brooks,* under construction for James J. McNally, was launched on August 10 at the yard of the Clinton Shipbuilding Company, Philadelphia. The new vessel is 195 feet long over all, 23 feet 10 inches beam and 15 feet depth of hold.

The new steel passenger and freight steamer *Henry R. Mallory,* of the Mallory Line, was launched on August 19 at the Newport News Shipbuilding & Dry Dock Company's plant, Newport News, Va. The vessel is being built for the New York-Texas trade, and is 439 feet in length, 54 feet beam and 34 feet depth. There will be accommodations for 100 first class and 100 second class passengers.

Marine Terminal Improvements

Snare & Triest Company, New York, were the lowest bidders for the construction of the pier shed at Fifty-fifth street and North River, New York. The amount of their bid was $337,751.

The Pennsylvania Lines West of Pittsburg are planning to extend docking facilities at Lorain, Ohio. Thomas Rodd, Pennsylvania Station, Pittsburg, Pa., is chief engineer.

The Baltimore & Ohio Rairoad Company, Baltimore, Md., F. L. Stuart, chief engineer, has appropriated $500,000 for improvements and additions to its docks at Lorain, Ohio.

The city of Muskegon, Mich., Paul Grimes, city engineer, is planning to build a pier.

The Standard Oil Company of New Jersey, Bayonne, N. J., has acquired a site adjoining Constable Hook, and plans to build wharves, bulkheads, etc.

The Lamport & Holt Steamship Company, New York, which operates a line of steamships from New York to Brazil and Argentina, has leased land in Hoboken, N. J., where it will construct two piers each 600 feet long.

The North Hudson Chamber of Commerce, George Limouze, secretary, 43 Columbia Terrace, Weehawken, N. J., is planning to build docks along the Hudson River.

The Port Commission, Astoria, Ore., is taking figures on a locomotive crane for the port docks.

The Minneapolis, St. Paul & Sault Ste. Marie Railway has awarded contracts for a reinforced concrete ore dock to be built at Ashland, Wis., which will have a total capacity of 60,000 tons. The structure will have a storage length of 900 feet, and will carry four tracks at an elevation of 80 feet above water level. Including a dock head of 75 feet the reinforced concrete portion of the structure will have a total length of 1,132 feet.

S. W. Bowen, chief engineer of the City Department of Public Utilities of St. Louis, Mo., in a recent report on a proposed terminal system for river traffic in St. Louis, estimates that to provide for present requirements, with a reasonable provision for future growth, four 300-foot docks would be required on Valentine street and the same number at North Market street. The estimated cost of these docks and warehouses, with their mechanical equipment, is $1,230,000. For extensions of the municipal railway system, about $554,000 would be required. Adding a reasonable percentage for contingencies, the total estimated cost of the whole municipal system would be $2,000,000 in round numbers.

The Chicago, Milwaukee & St. Paul Railway Company is extending its wharf system at Tacoma, Wash., by the erection of a new shed 175 feet in width by 1,000 feet in length; and the Oregon-Washington Railroad & Navigation Company has recently completed an improvement on the Middle waterway, by dredging, filling and the construction of the wharf and warehouse, to be occupied by fishing interests. In addition to these private improvements the Hylebos Creek Waterway Commission has recently let contracts for the dredging and dyking and reclamation work in connection with the improvements of the Hylebos Waterway, an undertaking similar in nature to the Duwamish Waterway project at Seattle.

Work was recently begun by the T. A. Scott Company, of New London, Conn., on the construction of a corrugated iron warehouse, 500 by 35 feet, on the State steamship pier in that port.

Baltimore's port facilities for the rapid handling of bulk cargoes and other heavy freight will be materially increased by the large, modernly equipped pier now rapidly being constructed at Canton, an industrial suburb of Baltimore, for the Clarence Cottman Company, Inc., an old-established firm of stevedores and steamship and forwarding agents. The pier will be 600 feet long on one side and 1,000 feet on the other, and on the shore end of this latter side will be erected a big sulphur storage warehouse having a capacity of 5,000 tons.

The pier will be provided with an electrically-operated unloading bridge, spanning four railroad tracks, and a high-speed box-car loader, these being especially designed for handling pyrites, sulphur and other ores, as well as all kinds of heavy freight, and later it is planned to add magnetic equipment for handling pipe, rails and other iron and steel products. Contracts were awarded to the Mead-Morrison Manufacturing Company, East Boston, Mass., and Chicago, Ill., for this equipment, which includes one unloading tower equipped with man trolley and operating a 9-ton grab bucket, and having a cantilever arm which extends over the hatches of steamers and enables the vessels to be unloaded at any point on the pier. A high-speed box-car loader, having a guaranteed capacity of 550 tons per hour, was also included in the equipment. The contract for the construction of the pier proper was awarded last May to the Sanford & Brooks Company at an approximate cost of $200,000. The construction is of reinforced concrete on timber piles, under the plans and supervision of the Cleveland Dock Engineering Company, of Cleveland, Ohio.

The Duluth, Missabe & Northern Railroad Company, Duluth, Minn., has announced that a new ore dock will be constructed on the site of Dock No. 2, and will cost approximately $2,500,000. The dock will have 384 pockets, each with a capacity of 350 tons of ore. All machinery on the dock will be operated by electricity. It is expected that the new dock will be completed at the opening of navigation in 1918.

The Pacific Coast Company has authorized the immediate construction of new terminals for the Pacific Coast Steamship Company at Juneau, to cost, exclusive of the ground site, about $80,000. The plant provides for a pier 480 feet long by 200 feet wide, with warehouses and fuel storage quarters covering about three-fourths of the floor space.

Shipbuilding Reports

A marked revival of the wooden shipbuilding industry is reported in Yarmouth, Nova Scotia. Twenty-nine sailing vessels, averaging about 250 tons each, have either been constructed during the present year or are in course of construction, which is about double the tonnage built in any recent year. Several new shipyards have been opened recently in Bigby County.

The monthly reports of the Bureau of Navigation show that 120 sailing, steam, gas and unrigged vessels of 28,682 gross tons were built in the United States and officially numbered during the month of July. Six of these vessels, of 16,567 gross tons, were steamships, the largest being the *William A. McDonagle,* of 7,811 gross tons, built by the Great Lakes Engineering Works at Ecorse, Mich.

The monthly report of the Imperial Japanese Department of Communications, as published on July 2, gives the number of seaworthy vessels in Japan as 2,146, with a total tonnage of 1,627,103. Of these 431 are ocean-going vessels of more than 1,000 tons each.

Outside of naval work, shipbuilding in Scotland decreased greatly in 1915, the greatest loss being on the Clyde. In 1914 the Scotch shipyards turned out 454 vessels of 508,945 gross tons and 540,290 horsepower, but in 1915 the total number of vessels built was only 207, of 233,501 gross tons and 205,288 horsepower. The total indicated horsepower of vessels built on the Clyde in 1915 shows a reduction relatively greater than the tonnage, the figures being 180,503, as compared with 496,120 in 1914.

According to figures compiled by the *Journal of Commerce,* from August 1, 1914, to August 1, 1916, a total of 1,486 merchant ships, aggregating 2,812,644 gross tons, were destroyed as the result of the war. Of the tonnage lost, 77.4 percent belonged to the Allied nations, 14.7 percent to the neutral powers and 7.9 percent to the Teutonic powers.

Lloyd's Quarterly Shipbuilding Returns

The returns compiled by *Lloyd's Register of Shipping,* which only take into account vessels of 100 tons and upwards, the construction of which has actually begun, show that there were 440 merchant vessels of 1,540,218 tons gross under construction in the United Kingdom at the close of the quarter ended June 30, 1916. The tonnage now under construction in the United Kingdom is about 117,000 tons more than that which was in hand at the end of last quarter, and about 33,000 tons more than the tonnage building 12 months ago. It will be understood that the rate of progress in merchant ship construction continues to be very much reduced in the present circumstances, and that the immediate output will be considerably less than that which would be obtained under normal conditions.

MARINE ARTICLES IN THE ENGINEERING PRESS

Equipment for Navy Yard Shops.—By Naval Constructor J. A. Furer, U. S. N. Paper describing arrangement of machines, method of drive and design and construction of concrete foundations for machinery. 6 illustrations. 13,000 words.—*United States Naval Institute Proceedings,* May-June.

The Passenger and Cargo Steamer Lesbian.—Description of single-screw vessel of 2,555 gross tons and 11 knots speed, driven by a triple expansion reciprocating engine and built by Messrs. W. Harkess & Sons, Ltd., at Middlesbrough, for the Elleman Lines, Ltd., for the Mediterranean trade. 2 illustrations. 1,800 words.—*The Shipbuilder,* June.

The Laws of Skin Friction.—By Charles H. Lees, D. Sc., F. R. S. Paper read before the Institution of Naval Architects, April 12, discussing the laws of skin friction of a fluid in stream line and in turbulent motion along a solid of great length. 6 illustrations. 3,800 words.—*Engineering,* June 2.

Reflections on the Great Sea Battle.—Editorial discussion of the lessons learned from the great naval battle between the British and German fleets off the coast of Jutland. 1,500 words.—*Engineering,* June 9.

The Effect of Bilge Keels.—By Prof. T. B. Abell. Paper read before the Institution of Naval Architects, April 12, describing experiments to determine the resistance of bilge keels to rolling. 6 illustrations. 3,000 words.—*Engineering,* June 9.

Oil Fuel.—By Ernest H. Peabody. Very complete paper discussing the production, refinement, distribution and use of oil fuel. Detailed description of apparatus and arrangements for burning fuel oil under steam boilers. 3 plates. 47 illustrations. 38,000 words.—*Transactions of the International Engineering Congress,* September, 1915.

Wave Proportions and Their Effects.—By Arthur R. Liddell. Discussion of the relations which the heights of waves bear to their length and their influence on the scantlings of vessels to resist bending moments due to wave action. 1,650 words.—*Engineering,* June 9.

Some Effects of the Bulkhead Committee's Report in Practice.—By A. T. Wall. Paper read before the Institution of Naval Architects on April 13, showing how the recommendations of the Bulkhead Committee will affect the design, construction and cost of several typical vessels. Approximate method outlined to facilitate the application of the new rules in design work. 20 illustrations. 3,400 words.—*Transactions of the Institution of Naval Architects,* 1916.

The Japanese Society of Naval Architects.—Brief account of the meeting of the Japanese Society of Naval Architects, held on October 23, 1915, with abstracts of papers on shipbuilding in docks, the breaking of propeller shafts, Japanese tonnage measurement, stress distribution in a plate, and longitudinal bulkheads and experience during the war. 5 illustrations. 2,000 words.—*Engineering,* March 10.

PERSONAL

A. H. Hanscom, formerly president of the Eastern Shipbuilding Company, New London, Conn., has been made general manager of the Robert Palmer & Son Shipbuilding & Marine Railway Company, of Noank, Conn.

Charles E. Hendrickson, for years chief accountant for Robert Wetherill & Company, Inc., Chester, Pa., has been appointed purchasing agent for the Sun Shipbuilding Company, of Chester.

OBITUARY

Ralph D. Williams, editor of the *Marine Review,* Cleveland, Ohio, from 1900 to 1915, died on August 14, aged forty-eight years.

J. K. Bythell, chairman of the Manchester Ship Canal Company, died at his home in Manchester on August 18.

George H. Carey, assistant treasurer of the William Cramp & Son's Ship & Engine Building Company, Philadelphia, Pa., died suddenly on July 22 at his home in Philadelphia, aged sixty-four years.

John Thomas Clark, formerly head of the Lehigh Coal & Navigation Company and of the Marine Department of the Lehigh Valley Railroad Company, died recently at his home in Port Richmond, Staten Island, aged fifty-nine.

John Albertson, a pioneer shipbuilder and founder of the Albertson Construction Company, died recently at his home in Greenpoint, Long Island, aged eighty-two.

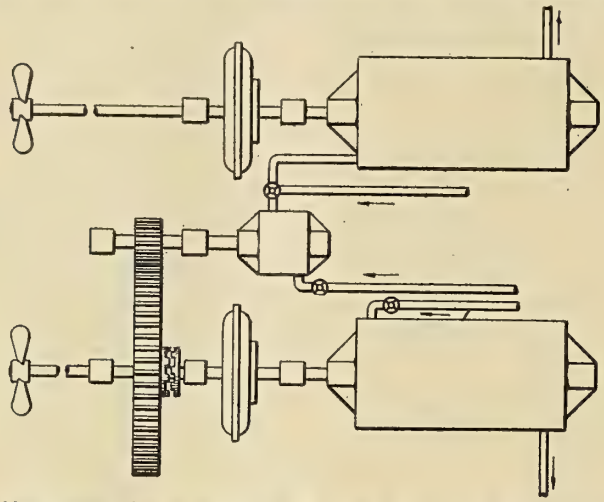
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,166,809. TURBINE POWER PLANT. HEINRICH ADAM BOHM, OF HAMBURG, GERMANY.

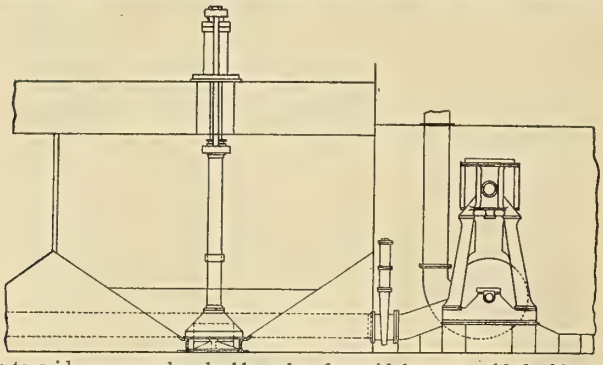
Claim 1.—A power plant including two driven members, two main turbines, two hydraulic power transmitters, each serving to transmit power from a turbine to its corresponding driven member, an auxiliary



turbine, means for transmitting the power from said last-mentioned turbine to one driven member and means for delivering the exhaust from said last-mentioned turbine to the main turbine of the other shaft. Fourteen claims.

1,187,250. HOPPER DREDGER AND BARGE. WILLIAM BROWN AND WALTER BROWN, OF RENFREW, SCOTLAND.

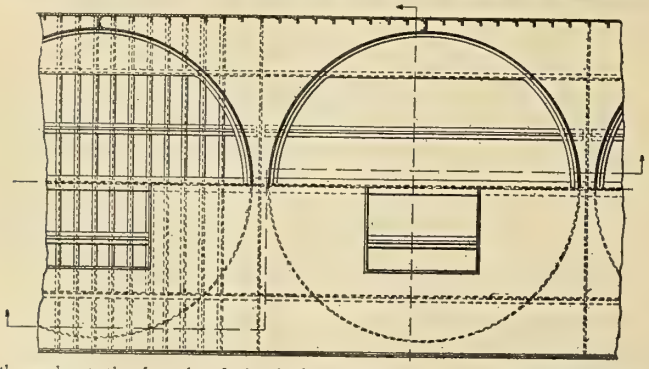
Claim 1.—In combination, a vessel provided with a hopper capable of being put in communication with the sea, a suction pump, a conduit lead-



ing to said pump, and a double valve for said hopper, said double valve comprising a member adapted to control communication between said hopper and said conduit, and a member adapted to control communication between said hopper and the sea. Two claims.

1,180,852. FLOATING VESSEL. CHARLES P. M. JACK, OF NEW YORK, N. Y.

Claim 1.—A tank vessel containing vertical walled tanks provided on each side with an upper longitudinal compartment and a lower longitudinal compartment the longitudinal walls of which are continuous

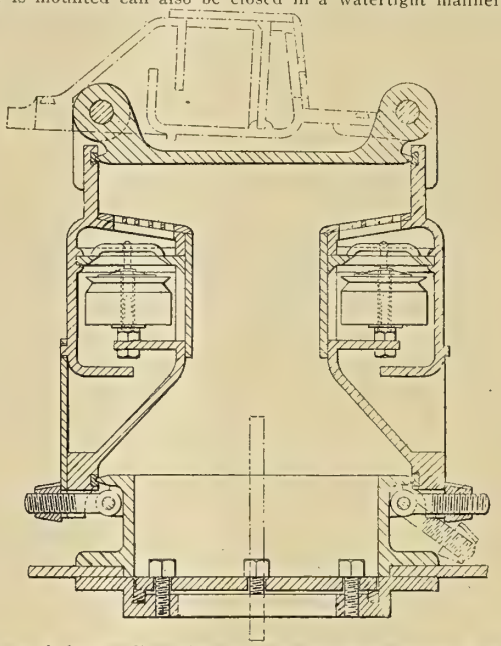


throughout the length of the body portion of the vessel, and connecting means between the compartments consisting of the side skin of the vessel and the portions of the tank side walls which lie between the compartments whereby the compartments are made to constitute upper and lower members of a girder for the longitudinal stiffening of the vessel. Two claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn place, W. C., London.

7,666/15. VENTILATORS FOR SHIPS. T. UTLEY, OF SEFTON HOUSE, CROSSBY GREEN, WEST DERBY, LIVERPOOL, LANCASTER.

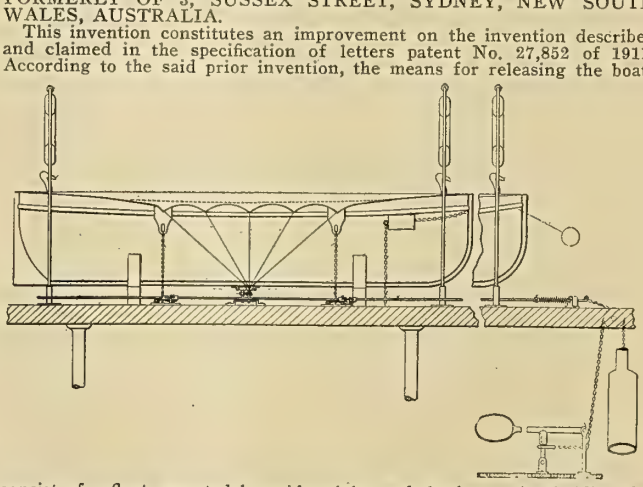
The chief object is to provide an improved construction of ventilator of the kind having valves to prevent ingress of water through the ventilation openings in rough seas. The improved ventilator is especially (although not exclusively) suitable for warships, in that it can be readily closed when the ship is going into action to protect the interior of the ventilator from the concussion of air due to firing of the guns; moreover, the ventilation aperture in the ship's deck above which the ventilator is mounted can also be closed in a watertight manner so that



in the event of the ventilator being destroyed or shot away by opposing gun fire there is no open passage through the aforesaid ventilation aperture in the ship's deck. According to this invention the main body or casing of the ventilator, which is adapted to be secured over the ventilation aperture in the ship's deck, is provided with one or more movable or hinged covers in which the air openings or ports leading to the interior of the ventilator are formed and in which valves are mounted so as to control the said air openings or ports to prevent ingress of water in rough seas, as aforesaid. In fine weather the covers are adapted to be readily moved into an open or inoperative position so that the air enters or leaves the ventilator through comparatively large apertures in the main body or casing without passing through the valve controlled openings or ports; the comparatively large apertures in the main body are adapted to be closed in a watertight manner by the covers in rough weather, for example. Baffles, or the like, may be provided in the air openings or ports in the covers to hinder any rush of water into the air openings or ports when the covers are closed. When the ship is going into action the valve-controlled openings or ports in the covers may be closed by suitable plates.

11,141/15. MEANS FOR SECURING SHIPS' BOATS INBOARD AND FOR RELEASING THEM AUTOMATICALLY OR AT WILL. T. OGILVY, OF 13 CRAIGHALL GARDENS, TRINITY, LEITH, FORMERLY OF 3, SUSSEX STREET, SYDNEY, NEW SOUTH WALES, AUSTRALIA.

This invention constitutes an improvement on the invention described and claimed in the specification of letters patent No. 27,852 of 1911. According to the said prior invention, the means for releasing the boats



consist of a float operated by said weight, and the boat gripe holding devices consist of a horizontal locking bar, and a pivoted cross bar adapted to engage with, and be withdrawn from an eye in, the locking bar. Now, various drawbacks arise from the use of a rope between the gripes of adjacent boats for the above-mentioned purpose, and in accordance with this invention the locking bars are connected with link mechanism and the operating means (i. e., float and weight mechanism), either through bell crank levers or directly, said link mechanism and operating means being common to a group of boats.

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U. S. PATENT OFFICE

Who Pays the High Cost of Freight Handling?

IN the marketing of almost any kind of commodity, one of the chief items of expense, if not the most important, is the matter of transportation and continual handling. The various commodities are produced in different districts restricted in their productivity by natural climatic or geographic conditions, but the use of these products in either their natural or manufactured forms is general throughout the civilized world.

It is in the moving of these raw products from the localities of production to the localities of manufacturing activity, and then again distributing the finished product to the consumer, that we are brought into contact with the activity of transportation in its many intricacies and variations. The products are carried here and there over the earth's surface, loaded into wagons, boats and cars; unloaded, trucked and carried into and out of stores, warehouses and factories, and otherwise handled many times in their passage between the producer and the consumer, through the hands of wholesalers, jobbers and retailers. While the cost of this handling must eventually be paid by the consumer, it is an expense that more immediately affects the producer and jobber, as on it largely depends their ability to meet the competition in their various markets. Any method, therefore, that will effectually reduce this expense by the saving of time or labor, will benefit everybody, enabling the producer and the jobber to meet competition in the most distant markets, and lowering the cost to the consumer.

Antiquated Terminals Must Go

A TRIP about the waterfront of New York City and the Jersey side of New York harbor discloses more typical wharves and sheds of an inefficient character than one would suppose it possible to collect, each bearing the earmarks of some original idea, but nearly all without any evidences that efficiency in cost, time or labor for the handling of cargoes had ever entered the head of anyone connected with the terminals.

Probably the building of most of them was deferred until it became necessary to rush the work through in the shortest possible time, when it was turned over to an engineer who knew more of waterfront foundations than of freight handling, with neither the inclination nor the time to investigate that phase of the problem, and with orders to rush it out in the usual rapid American fashion, and it was done.

It would seem that the time has come in which we must break away from typical methods and adopt new types if we are to keep up with the general trend, and particularly is this true of means and methods utilized in the conveying of cargoes between the holds of vessels and land carriers, for the limiting feature in the loading or discharging of a vessel lies not so much in the method used for moving the cargo between the wharf and the vessel's hold, although that is susceptible of improvement, as in the movement between wharf edge and trucks, or other carriers, through the storage reservoir.

The World's Greatest Port

NEW YORK is the most important port in the world. Forty-seven percent of the country's foreign trade is handled through this port, and the coastwise and river trade is much larger than the foreign trade.

New York has one of the best natural harbors in the world, but because of lack of co-ordination of terminal facilities an enormous amount of unnecessary work is done in handling these immense quantities of freight. Although New York has more waterfront than Hamburg, London and Liverpool combined, nevertheless Hamburg handles almost equal tonnage with only 24 miles of waterfront. London handles almost equal tonnage with 28 miles of waterfront, though handicapped by an 18-foot tidal range, and Liverpool handles almost equal tonnage in a small area, although handicapped by a 28-foot tidal range.

These three foreign ports are better equipped with terminal facilities, especially for warehousing, than is New York. In New York over 2,000 lighters, car floats, floating grain elevators, oil barges, coal barges, etc., are needed to handle railroad traffic alone. On account of these conditions, the movement of freight through New York is constantly handicapped by congestion on the piers and bulkheads, as well as on the adjacent streets and rail connections. Is it any wonder, then, that the cost of handling freight in New York, which is typical of American ports, forms such a big item in the total cost of transportation?

The improvements by which such conditions can be bettered and the handling of freight at marine terminals made more economical are legion. Many of them are explained in the following pages, and to those of our readers who are anxious to save a dollar here and there or add to their profits in the field of transportation we heartily commend them for careful study.

What Are the Facts?

RECENT reports in the daily press give the impression that the battleship *Arizona*, built in a Government navy yard, has been completed in record time and at a saving of millions of dollars to the Government.

On what basis these claims are made we are at a loss to understand. Although the statement has been made that the vessel was prevented from going into commission for a month on account of the lack of a crew, nevertheless investigation has shown that as late as September 15 the ship was far from completion and that at that time the main turbines had not been run under load.

As to the cost of construction of the vessel, it is understood that in the peculiar method of bookkeeping employed in the navy yards an overhead expense of only 32 percent is carried, whereas, if the recommendations of the board of the Secretary of the Navy were carried out, the overhead expense would be about 75 percent of the direct labor. It is also understood that other items, such as leave with pay, which properly should be charged against the ships, are not included.

The truth regarding this matter from the navy department would be gladly welcomed.

The Barge Canal?

In the forthcoming State election in New York it is to be hoped that officers will be elected who will bring about some change in the situation regarding the new State barge canal. We have on file a letter from the Deputy State Engineer referring to the fact that sharp curves in the canal will prohibit the navigation of boats larger than about 1,700 tons, regardless of the fact that the canal locks are designed to accommodate boats of 3,000 tons. This letter reads in part as follows:

"You are quite correct in stating that the canal will not be able to accommodate boats of 3,000 tons in the excavated sections, although the locks will accommodate boats of this kind. I am of the opinion that the largest boat which will be practical for use on the canal as now laid out will be about 1,700 tons, although I would call your attention to the fact that when the interests of commercialism call for the further development of the canal the locks will be able to accommodate boats of 3,000 tons capacity."

With the slowness with which the work is proceeding it looks as though it will be many years yet before the canal will be of commercial use, and, by the time it is ready for use, "commercialism will call for the further development of the canal" so that boats a good deal larger than "about 1,700 tons" can be used.

In another letter the Deputy State Engineer wrote under date of April 18, 1914: "It is expected that the entire system will be in use during the season of 1916."

The people of New York have appropriated approximately $125,000,000 (£25,600,000) to build a canal which it was "expected" would be in use during the season of 1916. As yet the canal is very far from finished, and it is so improperly designed that it does not seem possible that it can be of the desired commercial use, especially with the tendency nowadays of using boats of the largest capacity possible.

In spite of the "expectation" that the canal would be ready for use during the season of 1916, practically nothing has been done in the construction of proper terminals. Regardless of party affiliations, the legislative authorities in the State of New York should take hold of this barge question with a good, firm grip and give the people of the State a real canal with proper terminal facilities, and give it to them promptly.

Draft of Ships in the Panama Canal

In order to calculate the draft of a ship in the fresh water section of the Panama Canal, through Gatun Lake, Gaillard Cut, and Miraflores Lake, from her draft in sea water, the Marine Division forces have adopted as a working formula:

Add one-fourth of an inch to each foot of draft in sea water.

Accurate computation in this matter would require consideration of the displacement curve of the ship and the density of the water, as determined by hydrometer tests; but for practical purposes the simple formula is very satisfactory.

Where the water plane area is approximately constant throughout the draft, the draft of a ship in fresh water is about 3 percent greater than in salt water. This is based on the ratio of the volume of water weighing one ton. A ton of clean, fresh water contains approximately 36 cubic feet; a ton of clear sea water in the open ocean, approximately 35 cubic feet. The depth to which a vessel will sink, displacing water, till it reaches equilibrium will vary as the quantity of water required to make a ton. Accordingly, as 36 is greater by 2.857 percent than 35, the draft of a rectangular parallelepiped in fresh water is exactly 2.857 percent greater than in salt water. One-fourth of an inch is slightly over two percent of a foot; but on account of the sediment in the water in the Cut, due to the dredging operations, and also on account of the fact that the water plane areas are smaller near the keel than near the surface, the local formula gives more nearly accurate results with respect to passage through the Cut than the usual forms of rough calculation.

Harbor and Waterway Improvement Work in Russia*

At Vladisvostók during the past year extensive port improvements have been carried out to accommodate the largely increased volume of ocean traffic brought about by the war. The improvement work has been in general of two kinds; one, the dredging out of new mooring places for ships; and the other, the providing of new unloading facilities by means of floating and pier cranes. In addition, along this portion of the city waterfront, the open freight storage places have been enlarged, new roofed warehouses have been built, and spur tracks from the main railroad line have been extended to many places.

Across the peninsula to the west, in the Gulf of Amóur, new accommodations have been provided for coastwise traders; steamers at this port can now be unloaded into lighters.

Nikoláievsk, on the Amóur, which has also seen a considerable increase of shipping due to the war, has been improved in a variety of ways. As at Vladivostók, many new mooring places for ships have been dredged within the harbor. New dredges for this work have been ordered abroad and other dredges which had already been ordered for other work have been transferred to this as fast as they were completed. On the shore new embankments and warehouses have been built, and the general facilities for handling ocean freight have been vastly enlarged.

The Vólga-Donskóy Canal, by which the Don and Volga Rivers would be connected, has been seriously taken up at recent meetings of the Coal Section of the Special Conference upon Fuel. A report submitted by Professor Pouzirévsky gives the estimated cost of the construction of the canal as $25,000,000 (£5,125,000), and his presentation of the matter was considered a very favorable one by the Section. By various improvements on the plans referred to, it was asserted by other speakers that the canal could be completed within a period of two years. The transportation capacity of the canal was reckoned at a maximum of over 800,000 long tons, which by this means could be transferred from the Don Basin into Central Russia, where that fuel was very greatly needed. The success of the transport was declared to be dependent not only upon the building of the canal, but upon the

* From *Russia*, published by R. Martens & Co., Inc.

operating through it of a sufficient number of properly constructed cargo boats.

Moscow is expected to have a large new river port completed during the present calendar year as the outcome of agitation of the matter for some years, and a serious overtaxing during the past year of the city's river traffic facilities. The question originated several years ago as part of a project for improving the water route from Moscow to Nizhni-Novogrod. This route takes goods from Moscow on the Moskva River, which flows southeastward until it joins the larger Oká River, which in its turn is merged in the Volga, where it helps to form the promontory on which are the grounds and buildings of the Great Fair. For about ten years past there has been an annual increase of about 27 percent in the freight traffic through Moscow and over the Moskva River. The freight business of the Moscow portion of the river bank has just about trebled in a period of eleven years. The situation has become much more urgent through the congestion of freight brought in by the railroads. The rapid construction of a new river port seemed urgent months ago, and the Ministry of Transportation has begun upon the task. One advantage that the Ministry possesses in this undertaking is the command of the labor of a large number of prisoners of war; by using them it seems possible to put through the necessary work during this year's building season.

Inefficiency in Handling Imports

BY H. A. SPAULDING *

One of the great problems of transportation companies is handling freight at terminals economically. Comparisons have frequently been made of the extremely high cost of handling freight at terminals with the cost of actual transportation, either by rail or water, and practically all of the railroad, steamship and terminal warehouse companies are giving attention to the modern labor-saving devices with a view of reducing the cost of handling freight in their terminals.

Knowing that all of the transportation and terminal warehouse companies are striving to operate at a minimum cost, the writer has been forcibly impressed by the inefficiency in handling imports subject to duty. This is a condition beyond the control of the transportation and warehouse companies and has a great bearing on the high cost of operation in terminals.

For example, in handling raw sugar from steamships: first, it is hoisted from the hold of the ship in slings, lowered on small platform hand trucks and moved a short distance from the side of the ship and piled on the dock by men employed by the steamship company; second, handled by the government men on to scales and weighed; third, handled from the government's scales directly to the merchant's scales and weighed the second time; fourth, taken from the merchant's scales, loaded on trucks and trucked to storehouse or car. The government's scales alongside of the merchant's scales can be seen in Fig. 1, as well as the number of men required for the double handling. This not only means a double cost for weighing, but also delays the general operation.

With a little co-operation on the part of the transportation companies, merchant and government, a system could be worked out so as to eliminate the second scale and a number of laborers, which would greatly reduce the cost of operation, increase the speed of handling, and facilitate matters for increasing business.

The most economical method would be to provide platform scales in place of the present type that would weigh a loaded truck. By this means sugar could be hoisted from the hold of the steamer in slings, deposited directly on electric or trailer trucks, which could be towed by an electric tractor. The loaded truck could then pass over a scale and be weighed and continued to the storage house or car. This system would eliminate a number of handlings and greatly reduce the total cost, which the public eventually pays.

Several companies handling goods similar to the above have installed a number of electric trucks and tractors,



Fig. 1.—Weighing Sugar at American Dock

and in spite of present conditions reduced their costs to such an extent that the electrics have proved to be a well-paying investment. With a revised system, electrics could be worked more efficiently, as there would not be the delays in handling as at present, and more electrics would be placed in service, which would effect a far greater saving.

In brief, this would mean a saving of labor to the United States government, to the steamship companies and merchants, and a splendid investment for the terminal warehouse companies, which from their point of view, particularly under congested conditions, would open a way for an increase of business not to be overlooked, and at the same time reduce the cost of product to the consumer.

Marine Terminal Improvements at Port of Philadelphia

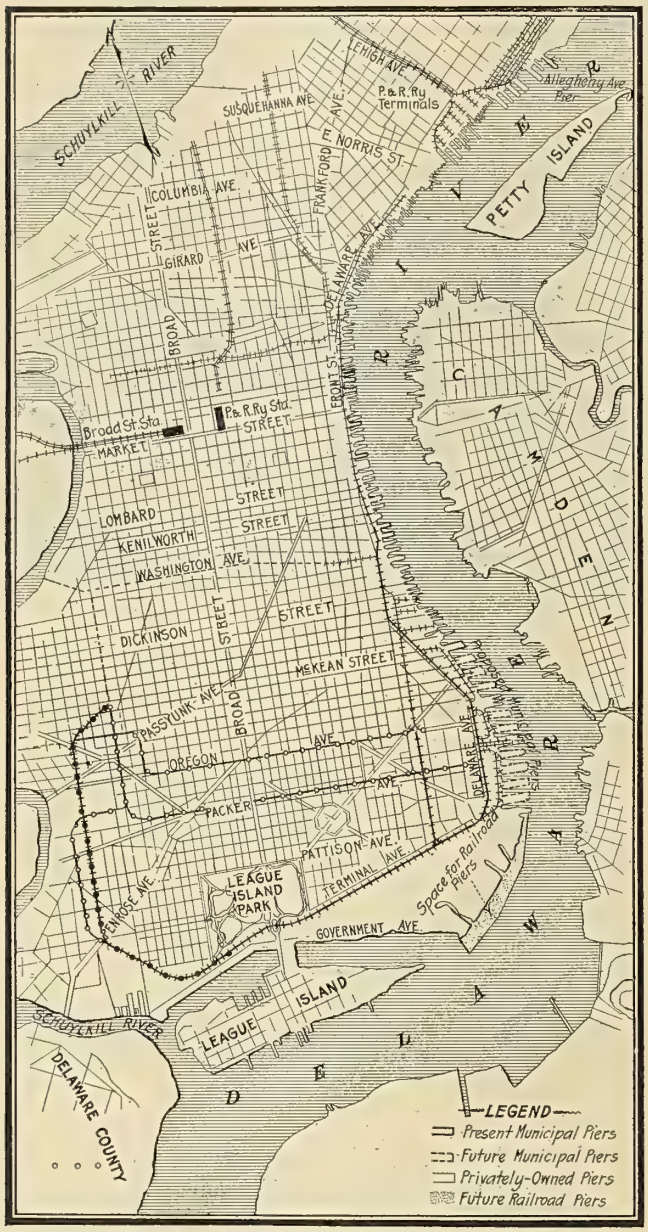
Progress is being made by the city of Philadelphia in its immense scheme to establish in the lower section of the city a great railroad freight terminal adjacent to a wonderful system of piers, now being constructed under the supervision of the Department of Wharves, Docks and Ferries.

During the last week in August certain tracts of land aggregating 340.77 acres have been transferred by individual owners to the Greenwich Terminal Company. Eventually, this land will be used as the site for freight terminal yards by the Pennsylvania Railroad Company and the Baltimore & Ohio Railroad Company. For years this land has laid dormant. Portions of it were farmed; other portions have been undeveloped because it is marsh. The total 340.77 acres has been assessed by the city at a value of $106,500 (£21,800).

The transfer of property mentioned involved values

* With the General Vehicle Company, Inc., Long Island City, New York.

given at approximately $4,500,000 (£924,000). The aggregate cash payments to the various owners was $1,440,482 (£295,500), and the aggregate ground rent encumbrance was $109,526 (£22,400), the principal of which, on a 4 percent basis, amounts to $2,738,100 (£561,000). This immense increase in valuation has been brought about by the announcement of the city's plans to improve the port facilities, to construct piers and great wharves, and to



Philadelphia Water Front, Showing Proposed Terminal Development

make at the lower end of the city a freight terminal that will be unequaled in capacity and equipment by any other terminal in the world.

The whole plan of development is progressing steadily. Eventually the railroad companies will acquire the same land which was transferred to the Greenwich Company, and it is expected that at least a million and a half dollars will be expended by these corporations in the construction of the several freight yards. The city's engineers have progressed rapidly with their plans for the improvement of the port.

A tentative estimate of the cost of the proposed improvements has been arrived at; and in his report to Mayor Smith, George S. Webster, the Director of the Department, calls attention to the importance of constructing new piers as rapidly as possible. He points to the fact that during the first seven months of 1916 the import and export trade amounted to $216,295,478 (£44,500,000), or $14,000,000 (£2,870,000) more than the total for 1915. The coastwise traffic was as great. These figures demonstrate the increasing business of the port.

Mr. Webster says further in his report to the Mayor: "In 1915 the gross tonnage of the arrivals of vessels from foreign and coastwise ports amounted to 9,315,157, and the clearances for the same period figured up to 9,377,901 tons. There can be no dispute as to Philadelphia's ranking as the second port in the United States. No person familiar with shipping conditions would, for an instant, entertain the thought that either Boston or New Orleans is of the importance of Philadelphia.

"The activities of the port were never greater than at present. There is a constant demand for space on the municipal piers. It is this condition which has increased our desire to push matters rapidly, and the engineers of this Department have been working upon the estimates of cost for these improvements."

The tentative figures of costs given by the Department engineers are as follows:

(a) To complete the McKean Street Pier (construction now under contract), which will be 250 feet wide by 900 feet long, of the two-story type, with pile foundation and with structural steel and reinforced concrete superstructure. Estimated cost	$300,000
(b) For the purchase of a site and the construction of a one-story pier, approximately 80 feet wide by 535 feet long in the vicinity of Cherry street, this being opposite the center of the city, to be used for the accommodation of river traffic. Estimated cost	750,000
(c) For the purchase of property and the construction of a double-deck pier, 80 feet wide by 550 feet long, similar to the present new piers in the Southwark Group, to be used for general commercial purposes, and to be located near the foot of Kenilworth street. Estimated cost	1,000,000
(d) For the purchase of property and extension of Allegheny Avenue Pier in the northern part of the city, for use as a general freight land for river steamers, and for recreation purposes. Estimated cost	500,000
(e) For the purchase of property and extension of the pier at Penn Treaty Park, also the pier at Bridge street, Bridesburg, for general freight landing for river steamers, and for recreation purposes. Estimated cost	100,000
(f) For the completion of the bulkheading of the Schuylkill River. Estimated cost	750,000
(g) For the acquisition of property and the erection of modern piers on the Delaware River front, south from the new McKean Street Pier, in what is known as the Moyamensing Group, and possibly for the erection of new piers in the northern central portions of the waterfront. Estimated cost	6,600,000
	$10,000,000 (£2,050,000)

Director Webster's communication says: "The agreement entered into in March, 1914, between the city and the railroad companies, provides for the sale to the city, for the purpose of erecting municipal piers, of about 2,500 feet of waterfront on the Delaware River by the Pennsylvania Railroad, a portion of which is now occupied by their Greenwich coal piers, and of about 925 feet of waterfront at Snyder Avenue by the Baltimore & Ohio Railroad Company. The loan provides $3,300,000 (£676,000) for this purpose.

"A feature of the South Philadelphia improvements is the extension of Delaware Avenue, the marginal commercial street along the river front which is now being extended to the southward to the width of 200 to 250 feet, which is believed to be ample for the accommodation of both railroad and vehicular traffic.

"The general plan includes the adoption of a street system, which provides a main avenue for traffic, attractive layouts for parks and playgrounds, a civic center of ample size and many attractive features which will encourage the general development of that section and make it more sanitary and wholesome."

What is to be Expected of the Shipping Bill?

Is it a Paternalistic Blunder or One of the Best Pieces of Constructive Legislation Ever Passed?

BY "OLD SCOTCH"

WHEN President Wilson affixed his signature to the Shipping Bill on September 7 last, that much discussed, much maligned and much misunderstood measure became a law after one of the stormiest voyages through legislative seas ever encountered. As it has finally been placed on the statute books, it is either a paternalistic blunder or one of the best pieces of constructive legislation ever passed in the interest of American shipping, according to your point of view. The latter is the writer's viewpoint, and it is proposed herein, as briefly as possible, to state how he arrives at that appraisal.

Formation of Shipping Board

First and foremost in importance is the formation of the Shipping Board itself. Now we are to have a finite head to the great shipping interests of the nation. Under the law it must be composed of men selected "with due regard to their fitness for the efficient discharge of the duties imposed on them," hence they will be men who know the shipping business. The great shipping industry has heretofore drifted along without any centralized authority. When Congress has desired data and advice concerning pending legislation, it has had no responsible source from which to obtain the facts. Many of the efforts towards constructive legislation regarding shipping have been handicapped largely because of that fact. Every other important maritime nation has an organization such as the British Board of Trade, which can and does pass upon important matters regarding its shipping.

One of the most important sections of the act is one about which but little has been written or discussed. I have reference to Section 12. In general, its requirements are that the board shall investigate the relative cost of building ships here and abroad, and the disadvantages of operating registered American vessels in the foreign trade. It shall examine the rules under which vessels are constructed abroad and the whole subject of marine insurance with a view of developing an ample American marine insurance system as an aid to the development of the American merchant marine. It is also directed to examine into all the navigation laws for the purpose of reporting to Congress what amendments, improvements and revision of such laws are necessary for the development of our shipping.

Clause Instigated by Marine Engineering

The Shipping Board is further directed to investigate the legal status of mortgage loans on vessel property, with a view to means of improving the security of such loans and encouraging investments in American shipping. In passing it might be well to note that this important clause was included in this section of the bill at the instigation of Marine Engineering.

One does not have to be more than ordinarily familiar with present conditions to realize the great importance of these instructions to the board. If, as many people believe, certain sections of the so-called Seamen's act ought to be modified or repealed, the favorable recommendation of the Shipping Board will be the only practicable means to that end. Much has been said and written about the inadequacy and antiquity of the various navigation laws. Their repeal or modification can only be brought about after an intelligent investigation and recommendation by the board. In fact, under Section 12, anything that pertains to the upbuilding of our merchant marine can be intelligently investigated and reported upon through the medium of the board. Needless to say, such recommendations will have more weight with Congress than any that have heretofore been submitted to it.

In my humble opinion the building of the proposed fleet, and the possible operation of some of its units by the Government, are matters of secondary importance in this important law. No sane person has ever thought that providing about 500,000 tons of naval auxiliaries, such as is proposed in this act, would furnish us with a merchant marine. It will be merely a demonstration fleet to encourage other Americans to go into the business.

None can deny after the expert testimony before the congressional committees, that the Government needs these ships for purposes of national defense, as auxiliaries to both the army and the navy. No sensible person would seriously advocate that such a fleet, after it is constructed, should be tied up in navy yards and allowed to deteriorate. It is entirely a logical proposition that they should be leased to shipping men and used for the purpose of extending our trade.

Competition With Private Enterprise

It is also entirely reasonable that other new lines are needed and demanded by our exporters, that in the absence of any private enterprise to establish them the Government itself, in the interest of all, should start the lines, and when they have been developed into paying properties to dispose of them to the highest bidders.

All the hue and cry about paternalism and government operation in competition with private enterprise has been the result of building up straw men and knocking them down. Section 11 of the act clearly provides that no corporation of which the Government is a stockholder, under authority of this act, shall engage in the operation of any of these ships until a bona fide effort has been made to contract with private parties to purchase, lease or charter them. Furthermore, there can be no Government operation of any of the ships after the expiration of five years from the date of the close of the European war. There will undoubtedly be a sharp demand for everything that floats for at least five years after the war is over, as the present deficiency in the world's shipping cannot be made up in that time. The chances, therefore, of the Government ever operating any of these ships is very remote, to say the least.

One of the greatest bugaboos connected with the act is the fact that Section 9 provides that foreign-built vessels admitted to American registry or enrollment and licensed under the terms of the shipping law, may engage in the coastwise trade of the United States. There are two good reasons why this need not worry those who, like myself, believe in keeping the coastwise trade for American-built ships only. The first is that foreign-built ships, complying with the requirements of this law, cost just as much and probably more at present than American-built ships. This is best evidenced by the number of ships now being built in American yards on foreign orders. The other reason is that I cannot conceive of the mental

attitude of the members to be appointed on the Shipping Board, who would wilfully open this gateway to an influx of foreign-built ships into the American coastwise trade, when the very objects of this new law are the "encouraging, developing, and *creating* of a merchant marine to meet the requirements of the commerce of the United States, etc." If such an attempt should ever be made, it does not require much prophecy to foretell the finish of the board which attempted it.

Coastwise Shipping Not to be Molested

The underlying reason for the insertion of this clause in the bill, I understand, was, for example, in the case of a foreign-built vessel purchased by the board and engaged in the foreign trade of the United States, arriving at one American port, say at New York, discharging her cargo there, and being engaged to carry her outbound cargo from a distant port such as New Orleans, to be allowed to carry a cargo from New York to New Orleans. Such procedure would not appreciably hurt any American-built vessels engaged in the same transoceanic trade.

It must be kept in mind that under previous laws foreign-built vessels owned by Americans can be registered under the American flag. Until war conditions made it desirable very few, if any, foreign-built vessels were ever put under the American flag and engaged in our foreign trade.

Section 9, if not abused, may, therefore, be very beneficial in promoting our foreign trade when normal conditions return.

The purchase of vessels by the board is surrounded by a number of safeguards put on in the Senate to satisfy the apprehensiveness of many that the board would not use good judgment. They are, first, that no vessel engaged in the foreign or domestic commerce of the United States can be purchased unless the owners thereof had decided to withdraw it from such commerce; second, no vessel under the register or flag of a foreign country engaged in war can be bought; third, no vessel of any kind which is not adaptable for the purposes specified, or which cannot by reasonable alterations and repairs be made so, can be obtained by the board, and fourth, no vessel which has deteriorated to less than seventy-five percent of its original efficiency can be bought, regardless of whether it could be repaired and altered and brought up to that efficiency. While it is extremely doubtful if the Shipping Board would ever purchase any such vessel without such restrictions, the insertion of these amendments evidently satisfied some elements which were skeptical on those particular points.

Rate-Controlling Features

There seems to be but little doubt as to the advisability of the rate-controlling features of the law: a perusal of the many sections of the bill relating to this feature leads to the conclusion that the functions of the board are not to fix rates, but to stop the well-known abuses which have crept into the shipping business, such as "deferred rebates," the use of "fighting ships," etc.

The elimination of two cabinet officers as ex-officio members of the Shipping Board seems to meet with general approval. The same cannot be said in regard to the reduction of the salaries of the members of the board from $10,000 (£2,050) to $7,500 (£1,538) per annum. Capable men for such an important duty make much more money in private life than the latter salary, and it will result no doubt in handicapping the appointment of high-class men for these positions. So much depends upon the qualifications of the commissioners as to the ultimate success of this entire venture that it is regrettable, to say the least, that this cut in salary was made. Better by far had the salaries been fixed at twice the amount, as the importance of the shipping industry to this country fully warrants the best men obtainable.

The concluding clause of the law, designed to offset any attempt to blacklist American merchants by the refusal of foreign ships to receive their cargoes without good and sufficient reasons, is of far-reaching importance at the present time.

Taken all in all, it is believed that the operations of the new shipping law in its entirety will prove of the greatest benefit to American shipping, and that many of its opponents will be agreeably disappointed by its results.

Corporation Formed to Study Terminal Problems

Announcement was recently made in New York City of the organization in the State of Delaware by the National City Company, Stone & Webster, and the American International Corporation interests of a corporation to be known as the American International Terminals Company for the purpose of studying problems relating to railway, steamship, warehouse and industrial terminals. It is a well-known fact that the capacity of a railroad is limited by what its terminals can handle. Likewise, the greatest preventable waste of the available time of cargo ships occurs at docks and anchorages incident to loading and unloading. Transfer facilities in general are more difficult, more costly and less understood than the straight carriage of goods by rail or by boat. So many propositions for the improvement of terminals of all ports of the world have come up that it seemed advisable to form a corporation properly organized and equipped to study the one broad subject of terminal facilities.

The National City Bank has for the past two years been building up a special commercial service in the aid of foreign trade. Its numerous branches in the Latin-American countries and the branch it is now organizing in Italy put the City Bank into direct relation with shipping problems. Its interests in the new corporation will be represented by officers of the National City Bank.

That the American International Corporation should take an interest in the Terminal Company is to be expected, as shipping and shipping facilities have claimed its attention from the start. Its holdings in the International Mercantile Marine and the United Fruit Company, and its control of the Pacific Mail Steamship Company, explain its direct contact to a large number of ports throughout the world. In many of these ports there is great waste of effort caused by inadequate or badly arranged facilities.

Stone & Webster, the other stockholder, is perhaps the largest engineering and construction firm in the United States. They have a highly developed engineering organization and technical staff of known efficiency in these lines.

The new corporation has retained as consulting expert Mr. Will H. Lyford, who for more than thirty years has been connected with the largest terminal railway system in Chicago, and has co-operated in shipping terminals in several other cities. The directors of the corporation include George S. Baldwin, vice-president, American International Corporation; William S. Kies, vice-president, American International Corporation; Richard P. Tinsley, secretary-treasurer, American International Corporation; James H. Perkins, vice-president, National City Bank; Edward P. Courrier, National City Bank; Charles E. Mitchell, vice-president, National City Company, and Edward S. Webster, Henry R. Hayes and Oscar E. Stevens, all of Stone & Webster.



(Photograph by the Pictorial News Company)

Shipping Exports to Russia from Bush Terminal Piers, Brooklyn, N. Y.

Motor Trucks at Steamship Terminals

Average Saving of Over 36 Percent in Ton-Mile Cost of Hauling With Motor Vehicles—Other Benefits

BY H. C. HUTCHINS * AND H. W. PERRY †

IT is doubtful if more than one in fifty of the trucks and wagons used by shippers for hauling freight to and from the steamship piers in New York is motor driven. A similar condition prevails at steamship terminals in other seaboard and Great Lakes ports. The horse-drawn vehicle practically monopolizes this field everywhere, notwithstanding the rapid increase in the use of motor trucks throughout the country and the demonstrated superiority and economy of motor haulage. Many large manufacturing and mercantile houses would prefer to use motor trucks for hauling to and from the piers, and it would be to their advantage and to the advantage of the steamship companies if they could do so, but there are a number of conditions that make it impractical.

Most important of these is the long delays of vehicles at the docks waiting to load and unload goods. It is not at all uncommon for teamsters to wait one, two or three hours for a chance to get onto the piers. There is a tremendous congestion of vehicles in front of and on the piers in lower New York, and often a truck cannot haul more than two or three loads in a day, although the length of haul may be not more than a mile or two. Now, it is one of the axioms of the motor truck industry that these vehicles must be kept moving at least half of the working hours of the day; otherwise it is cheaper to use horses. Their function is transportation, and, like a steamship, they are losing money all the time they are standing still, and they lose it faster than a standing team, because there is a larger investment of money tied up in them, a higher rate of depreciation, and the individual machine costs more to operate and maintain than a team and wagon. On the other hand, when moving, the greater capacity and speed of the motor truck enables it to do the work of at least three teams, so that, under ordinary conditions, it is more economical than teams.

In the second place, when the trucks finally get on the piers, the actual loading or unloading takes an unnecessarily long time, which further impairs their usefulness by increasing their standing time.

Again, the admission of gasoline (petrol) trucks to some of the piers is still prohibited because, under the rule of the Board of Fire Underwriters, a higher rate of insurance is charged on the dock property if such vehicles are allowed upon it. A few years ago most of the steamship companies barred gasoline (petrol) trucks on this account, but now all but a few admit them, although the insurance companies still discriminate against them with

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a higher premium rate. The most important of the piers from which they are excluded are those of the International Mercantile Marine.

A great deal of the hauling to and from the piers is done by public draymen, who, for the reasons stated, and because most of the trucking is short-haul work to downtown warehouses and stores, have not adopted motor trucks. But there is another element of some importance in the situation, and that is the prejudice of teamsters and stevedores, who use various tactics to delay and hamper the movement and loading and unloading of motor trucks.

Undoubtedly the general use of motor trucks by shippers and draymen would benefit themselves and also the steamship companies. This is indicated plainly by their very extensive and successful use in many other kinds of work and by their rapid increase in number. So far as the shipper and draymen are concerned, they would profit by the lower cost of hauling by motor truck. Just how much less this cost would be cannot be stated for this particular line of work, but carefully compiled records of costs of the hauling and delivery services of fourteen prominent companies engaged in different lines of business in ten large cities show the average ton-mile cost of hauling with motor vehicles to be 11¼ cents, as compared with 17¾ cents by horse-drawn vehicles. This is an average saving of 36⅔ percent. These costs include all items involved in the services, such as drivers' wages, interest and depreciation, insurance, storage, repairs, fuel, oil and tires. The businesses represented are contracting, cut stone, expressing, coal, oil and dressed meats.

Gains for Steamship Owners

As for the steamship companies, it must be obvious that whatever will aid in clearing quickly the piers and docks of accumulations of freight and shorten the loading and discharge of cargoes so that ships can get under way again, will be to their advantage. Ships, like motor trucks, earn money only while they are in motion. Their sole function is carrying, and every day or hour they are tied up in port reduces their earning capacity.

Considering this evident fact and bearing in mind the highly efficient methods of loading and discharging grain, iron ore, coal and oil in use on the Great Lakes and at the Standard Oil Works, whereby huge steamers are loaded and unloaded in a very few hours, the methods of handling freight still in vogue at most piers are surprisingly antiquated and inefficient. There is almost a complete lack of modern mechanical means for loading and discharging cargo, for moving it on the docks and piers and for loading and unloading trucks and drays.

A number of causes account for this. Miscellaneous cargo cannot be handled by a single mechanical method, as grain can be discharged from elevators through chutes into the hold, or as coal can be dumped by the carload simply by tipping a railroad car over in a crane, or as oil can be run through pipes. Moreover, a considerable number of the piers in New York are owned by the city and rented to the steamship companies, so that installation of any improved mechanical devices must wait upon the city and the recommendations of the Department of Docks and Ferries.

Granting these conditions, the facts remain that the marine terminals in general are far from up to date in freight-handling methods, that shipping and vehicular congestion are almost intolerable, that port facilities might be increased several fold by intelligent study, that steamship companies and dock property might increase their earnings materially and that shippers and consignees could be saved a great deal of annoyance and loss if the piers were modernized and freight were handled systematically.

The steamship and railroad companies and other owners of dock property could very well take some lessons in efficiency methods from large modern industrial plants, warehouses and even department stores, contractors and small factories. These plants make use of every conceivable modern mechanical time-saving and economical device for handling goods and materials of all descriptions. Up-to-date factories are systematized to the *n*th degree, so that there is a steady progressive movement of materials and parts, from the raw materials entering at one end to the finished product emerging on the shipping platform or aboard ships, cars or trucks at the other. It is thus that production costs have been reduced. Some of the large new automobile factories are marvelous examples of this systematic arrangement and the quick and economical handling of materials and parts by mechanical means. What such systems and methods mean in efficiency will be understood from the fact that in one automobile factory 250 cars are assembled in nine and a half hours. The time for assembling each car, from start to finish, is three and a quarter hours.

Freight Handling in Warehouses

The great new warehouse of Austin, Nichols & Company, wholesale grocers in Brooklyn, affords a fine study in expeditious handling of miscellaneous goods. Railroad tracks pass through the full length of the building at one side, with loading platforms on either side. There are docks at one end on the East River, and at the other end is a covered loading platform for road vehicles. Down the center of the shipping floor are belt conveyors, and from top to bottom of the building there are three groups of spiral chutes communicating with all floors. Incoming goods are raised to the upper floors by large elevators, of which there are eight. The goods are handled by electric factory trucks or by hand trucks. Outgoing shipments are carried on these trucks to the spiral chutes on the different floors and descend by gravity to the ground floor nearest to the point whence they are to be loaded into ship, railroad car, or motor truck or wagon for local delivery. Some of the chutes discharge upon the conveyors and others upon the floor. Thus the trucking within the warehouse is minimized and the goods moved as rapidly as possible. The elevators are used very little for descending freight. Groceries are stored, of course, very systematically, so there are no delays in filling orders from stock.

Mechanical Appliances

In addition to these systems and appliances, many mechanical devices are in use among manufacturers, merchants, shippers and others, such as traveling cranes, escalators, overhead trolley or telfer systems, bucket conveyors, etc. Certainly some of them might be used advantageously on steamship piers, and it appears that the time is ripe for a wholesale revolution in freight handling at steamship and railroad terminals. There is no apparent obstacle to building six-, eight- or ten-story warehouses in combination with the docks, the first two or three levels to be used by the steamship companies and the upper floors as warerooms to be rented to manufacturers and merchants, as is done by the Bush Terminal Company in Brooklyn. Systems of chutes, ramps, conveyors and elevators could connect these floors with the shipping floors.

One of the two lower floors could be devoted to incoming cargo and another to outgoing. This would prevent confusion and also enable the operations of discharging

COSTLY CONGESTION AT NEW YORK MARINE TERMINALS



Photograph by Edwin Levick, N. Y.

Hand Trucking Coffee with Three Men to a Truck



Photograph by Pictorial News Company, N. Y.

Handling Raw Sugar at Bush Terminal Piers



Overflow of Freight from One of the North River Piers Piled Up on Farm



Interior of Jersey Central Pier, One-Story Construction, Lack of Loading and Unloading Facilities



Photograph by Edwin Levick, N. Y.

Interior of Hamburg-American Pier, Showing Railroad Down Center, but no Platform at Level of Car Floors



Photograph by Pictorial News Company, N. Y.

Interior of North River Pier, Showing Floor Congestion and Shed Space Not Utilized

and loading ships to be carried on simultaneously. As soon as one hold is emptied, reloading could begin while the next hold is being discharged. In this way the waiting time of the ship could be cut down nearly one-half. Conveyors, power trucks and other mechanical devices should be used in this work wherever possible instead of hand trucks.

Clearing freight from the receiving floors would be greatly expedited by having the freight platforms raised to the level of the wagon and truck beds, as at railroad



Slow and Costly Method of Discharging Cotton Cargo

freight houses, so that freight could be run directly on and off on small trucks or rollers. Under the prevailing arrangement everything has to be lifted up to and down from the body of the vehicle at a tremendous waste of time and effort. A ramp 16 or 18 feet wide and with a grade of, say, one in five, would permit vehicles to drive up to the second level, passing descending vehicles on the way. It might even be feasible to build a huge conveyor or moving sidewalk sunk to the level of the freight platform or floor of the pier, passing up one side and down the other. Goods from the ships could be discharged directly upon this and taken off as they pass any given numbered or lettered section on either side of the pier.

It seems hardly necessary to call attention to the desirability of segregating freight by name of consignee, so that the driver of a vehicle calling for it can locate his consignments immediately and get at them for removal without difficulty. Many of the companies make a practice of doing this, among them the New York Dock Company and the International Mercantile Marine. The former has the pier sections numbered and marks these numbers on its check sheets, so that when freight bills are matched with the check sheets the numbers are transferred to the freight bills to show consignees where to look for their goods. The same system is also used at other piers.

It is equally desirable that the handling of all records of freight in the offices be thoroughly systematized, so there will be no delays there in giving the location of consignee's freight to the driver, getting his receipt and letting him begin loading. In short, everything possible must be done to enable drivers to get into the piers, load or unload, and get away again without delay of any kind. When these long delays, so common at present and in the past, are eliminated, motor trucks will come into more general use at the terminals. This will help the steamship companies to clear their floors more quickly, because the trucks will make more trips per day than teams, they take up less room on the piers than teams and wagons, giving more room for freight; they are cleaner and more sanitary than horses, and can be backed into position to load or unload more quickly and with less noise and confusion than teams.

New York Terminals

There has been much talk in past years of the inadequate shipping facilities of the port of New York, and the congestion of freight during the two years of the European war has emphasized this condition. The city is undertaking the construction of large new piers at Forty-sixth street, work has been in progress for some time on the development of great docks in Jamaica Bay, and a new company has been formed for the building of a railroad and steamship terminal at Bayonne, along the lines of the Bush Terminal in Brooklyn. Yet the existing piers in the North and East rivers have not been utilized to anything like their maximum capacity. They might all be double or triple decked, equipped with mechanical loaders, and the handling of freight systematized. Much more extensive use could be made of electric stevedores in place of the prevailing hand truck.

The average cost of operating these electric warehouse trucks is less than $56 (11/13/4) a month, including wages of the operator, and they effect an average saving of $100 (20/16/8) a month apiece over the cost of doing the same amount of work with hand trucks. These averages were obtained from actual cost records of one year's operation of fifty-five electric trucks in a dozen different cities. Each truck has a capacity of two tons and a speed, loaded, of five miles an hour. H. B. Whipple, general manager of the New York Dock Company, states that under favorable conditions the electric tractor used for pulling large 4 by 14 foot dock trucks on the bulkheads and in the warehouse should save from 25 to 40 percent in the cost of shifting freight. The saving varies with the kind of freight, the amount handled and the distance it has to be moved. For trucking short distances, he says, a well-balanced system with hand trucks is hard to beat. However, where there are inclines to be mounted, each hand truck sometimes requires three men. The advantages of the electric truck are found, says Mr. Whipple, in the cases of long trucking, by reducing the number of men required and by doing the work more quickly than with horses or mules.

It has been estimated that more than 600,000,000 tons of miscellaneous freight are handled annually at marine terminals. The question of handling this enormous tonnage more expeditiously and economically involves not only the use of motor trucks, but also of system and all sorts of mechanical aids which will make the use of motor trucks by shippers and consignees of advantage to them. The use of motor trucks would reduce by at least one-half, and possibly by two-thirds, the number of vehicles em-

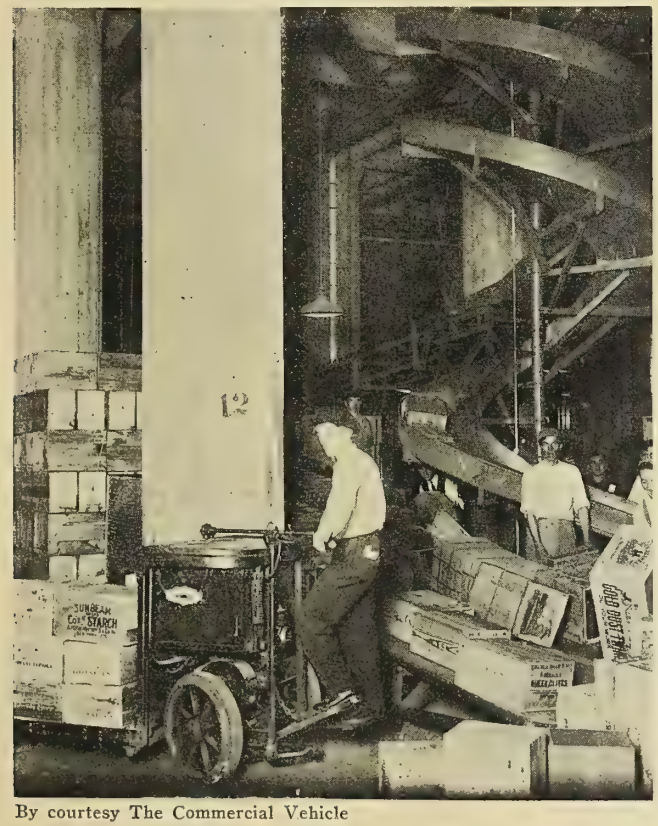
ployed in hauling from the piers. The cost of operating a five-ton motor truck averages about $15 (3/2/6) a day, everything included. One can be rented for $20 (4/3/4) a day, with driver. If the total standing time of the machine is five hours a day, due to waiting to get on the piers and to loading and unloading, there is a loss of $7.50 to $10 (1/11/3 to 2/1/8) through no fault of the owner or maker of the truck.

The motor truck has helped solve the serious problem of congestion of city streets and can do as much for the congestion at steamship terminals if given the opportunity. In the four years from 1911 to 1915 the tonnage carried by the streets of Manhattan increased 140 percent, while the number of vehicles increased only 72½ percent, due solely to the increased use of motor vehicles. The tonnage capacity per vehicle increased from 1.89 tons in 1911 to 2.63 tons in 1915, or three-quarters of a ton.

Use of Motor Trucks Rapidly Increasing

Traffic counts made by the Department of Public Works indicate that in a very few years the motor vehicle will constitute practically all of the vehicular traffic in New York streets. On Eighth avenue, at Forty-second street, the number of horse-drawn vehicles passing in ten hours, from 8 A. M. to 6 P. M., rose slightly from 4,528 in 1911 to 4,898 in 1915, while motor vehicles increased from 1,728 to 6,606. The number of motor trucks alone increased in that period from 537 to 3,309, or 516 percent.

Even with the present inefficient arrangement and equipment of the docks, the motor truck has numerous advantages so far as the steamship companies are concerned. In addition to those already mentioned, some of the trucks are provided with power winches operated by the engine or battery of the vehicle. This makes it possible to draw heavy crates, pieces of machinery, etc., on rollers and skids into the bed of the vehicle by power, greatly reducing the loading time. A great variety of methods of loading and unloading motor trucks have been developed and put into successful use.



By courtesy The Commercial Vehicle

System of Chutes, Conveyors and Electric Warehouse Trucks Used in Brooklyn Warehouse



Freight Escalator

The problem is not one of adapting the motor truck to freight terminals, but of adapting the terminals to the use of motor trucks so that advantage may be taken of their greater capacity, speed and economy. Seventy percent of all the traffic in the streets of New York is now by automobiles and motor trucks. The number of these vehicles has increased more than 108 percent in the last five years, while horse drawn vehicles have decreased 1.67 percent. Yet, for the reasons stated, motor trucks are hardly used at all around the docks and piers, and to only a slightly larger extent at railroad freight houses.

It is of interest in this connection to note the report made in 1914 by the Boston Chamber of Commerce after a careful study of traffic conditions in the Hub. Regarding steamship terminals, the report says:

Conditions in Boston Terminals

"The conditions at the steamship terminals affect street traffic of Boston in the same way as conditions at the railroad terminals, because if loading and handling of freight at these points is slow, teams and trucks are delayed, causing congestion at the terminals and frequently causing additional teams to be used, whose use would not be necessary if the teams first sent could get away from the terminals promptly.

"Failure to pile freight in an orderly and systematic manner causes much difficulty and seems to result from the lack of central authority for compelling it. . . . It would seem to be desirable to have certain well-defined rules regarding the assembling and piling of freight for different shippers and receivers, and to compel obedience to these rules. . . .

"A receiving platform, with checkers to give receipts, should be provided at the end of the wharf, nearest the street, or as near this point as possible, at which teams with small shipments could make deliveries and get their receipts without going the whole length of the wharf. It would seem to be simple common sense also that a method should be adopted for locating consignments of inbound freight so that loads for different consignees could be made up readily without unnecessary search.



Perspective Drawing of Proposed Water Gate for Honolulu

"If the cost of waiting time for teams and drivers occupied by searching for unlocated consignments were charged as a separate item on bills for teaming, there would be bitter complaint from the consignees at once.

"There seems no good reason why goods which are to be forwarded in bond should not be kept separate from free goods, and packages ordered to the appraisers' stores should be placed in one definite section of the dock, easily accessible to the bonded teamsters. . . .

"We recommend that goods remaining on the dock after a proper period be actually sent to a warehouse and the dock cleared.

"The inconvenient arrangement of the approaches and the inadequate size of some of the docks are matters of common knowledge. We would call attention to the satisfactory working of the two-floor dock of the Hamburg-American Line at Mystic wharf. Here import cargo is put on the lower floor and teaming is from the upper floor, from which the export cargo is loaded into the ship. Such an arrangement offers obvious opportunities for systematizing the handling of freight."

Final solution of this whole problem will not be found until the steamship and railroad companies are induced, or forced, by complaints against unnecessary shipping delays and excessive port charges, to undertake the collection and delivery of freight as a natural part of their functions as carriers, just as the express companies and the United States postal service do. When the transportation companies take over this work they will quickly realize the inefficiency and lack of economy that prevail at the terminals and will begin at once to rectify matters. They will find that the use of motor trucks under advantageous conditions is so superior to and so much cheaper than horse-drawn vehicles that the piers and freight houses will be modernized to facilitate instead of hindering their employment. And the collection and delivery of freight by large fleets of motor trucks operated by the carriers themselves will be so much quicker and cheaper than the present system of haulage by individual shippers, consignees and public truckmen, that everyone will wonder why it was not done long ago.

The present system can be compared with the situation that would exist if the express companies or the parcels post required the senders of parcels to bring them to the express houses or the general post office, and the receivers to locate and remove packages when called for at the receiving stations adjoining the railroads.

It would be cheaper for the shipper and consignee to have all hauling of freight done by the steamship and railroad companies, and the carrier companies could reduce the cost of this haulage so greatly by operating large fleets of trucks, installing time-saving mechanical devices and systematizing the classification of freight and the clerical work in their offices that they would make additional profit on the work.

Marine Terminal Proposed for Honolulu

William T. Donnelly, consulting engineer, of New York, recently submitted plans to the Harbor Commission of Honolulu for a water gate or marine terminal designed not only to provide a suitable entrance for all passengers arriving at the city by steamer, but also to provide a recreation center upon the water front for recreation purposes.

The plans contemplate a pier 200 feet in width by 600 feet in length, so located on the water front as to make it readily possible for all entering passenger steamers to touch at the outer end or head of the pier and land passengers and their baggage with the least delay and then to proceed to other piers for the unloading of cargo, touching again at the passenger pier upon their way out.

For recreation purposes the pier is so arranged that in the center is a swimming pool, 100 feet wide by 400 feet long, suitable for holding water carnival events. The architectural features of the design were worked up under Mr. Donnelly's direction by Mr. Bloodgood Tuttle, an architect of New York, who has adapted in the design features which are characteristic of the country and city which the pier is designed to serve. The landing from vessels at the head of the pier is under an arch 100 feet

in span at an elevation of approximately 30 feet above the water. At this level a gallery or deck 50 feet in width extends the entire length of the building on each side, with stairways to the lower street level and to an upper gallery. This arrangement makes possible a seating capacity in the structure of between 20,000 and 25,000 persons.

Recently the Harbor Board of Honolulu authorized the Superintendent of Public Works to proceed with work on sketches for a recreation pier on which will be an auditorium capable of seating several thousand persons. Favorable action is anticipated on the construction of such a pier, although the facilities for adapting the pier as a marine terminal as outlined by Mr. Donnelly in his proposed designs have not as yet been included in the plans.

Advantages of Motor Trucks for Use on Steamship Piers

BY R. O. PATTEN *

Motor trucks have taken so essential a part in the transportation systems of every merchant or manufacturer that steamship companies have nearly all given up their effort to bar gasoline (petrol) vehicles from piers.

In many sections of the country there were, for a long time, rules that barred gasoline (petrol) trucks from piers. This was one of the conditions that had to be changed before Pierce-Arrow trucks could be used to their full advantage in all-around delivery service. It took a campaign of education finally to bring around officials to see the injustice and absurdity of this course, but the reform has been accomplished, and with few exceptions all piers now put gasoline (petrol) trucks on the same basis as all other vehicles.

The freedom of action now permitted has opened the way to a large saving of money and a big improvement of service for many truck users. No longer do such users find it necessary to have a combined delivery, part horse-drawn dray and part motor truck, as was necessary when gasoline (petrol) vehicles were barred from going on the docks. This often compelled hauling from the wharf to the warehouses by horses, and then changing the cargo and completing delivery to the purchaser by use of the power vehicle. This reloading cost valuable time and wasted money.

The truck receiving its load at the pier and taking it direct to the final destination is giving the ideal kind of delivery. The whole proposition is thus made direct and the reload is eliminated. Much that comes in to a pier can be handled in this way.

It is true that delivery problems at a wharf must always be complicated by some inseparable disadvantages. These affect all kinds of vehicles equally. Congestion of traffic deals no more kindly with a motor truck than a pair of horses. Both have to take their turn in line and stand there the same length of time. This lost time naturally involves a greater loss with the truck, whose first cost was far greater. But once on the wharf the truck can work all around the horse-drawn vehicle.

It is conceded that the truck is more costly while standing side by side in line with the waiting horses, but in the time spent on the pier, the advantage is all in favor of the truck, a result largely due to the great facility with which it can be maneuvered and its greater capacity. Add to this the greater speed between the shipping point and the pier, and it will be seen that the element of economy is with the truck, the proportion of saving increasing with the covering of additional distances.

Even for short haul work most users of motor trucks employ them for hauling to the piers.

* Truck Sales Manager Pierce-Arrow Motor Car Company.

Loading Dock of Freeport Sulphur Company, Freeport, Texas

At their mines at Freeport, Texas, the Freeport Sulphur Company recently completed a loading dock 250 feet long and 32 feet wide on which is a superstructure extending 44 feet above the level of the pier and tapering from a width of 20 feet to 16 feet. The pier is built of timber, the piles being creosoted and the superstructure treated with zinc chloride and painted with iron oxide and linseed oil.

Fifty-ton cars are loaded at the company's bins and delivered to the top of the pier by a 200 horsepower double Lambert hoisting engine 15 inches by 18 inches, which hauls the cars up the incline by a 1⅜-inch cable. From the superstructure the sulphur is discharged into chutes leading directly into the vessel alongside the pier. The chutes are telescopic and when not in use can be folded 4 feet within the clearance line of the pier.

This loading dock permits the loading of a 3000-ton vessel between tides. The structure is lighted by electricity and has water and fire protection. The Westinghouse, Church, Kerr & Company, New York, designed and constructed the pier as well as the entire plant for the sulphur company.



Timber Pier of Freeport Sulphur Company, Built by Westinghouse, Church, Kerr & Co., New York



Courtesy of New York Edison Company

Accumulation of Miscellaneous Freight on Pier Before Application of Electric Industrial Trucks. Wagons Blocking Roadway and Causing Congestion

Helping the Electric Stevedore

Practical Hints for Improving the Service of Industrial Trucks, Tractors and Trailers at Steamship Piers

BY H. C. YOST *

THERE is a widespread and general interest in the problem of handling material at railroad and steamship freight stations, but thus far this interest has confined itself to the broader aspects of the problem. As little if anything has been said of the ways by which the best results may be obtained from the equipment already in use, a few hints on helping the "electric stevedore" in its very exacting work may not be amiss. The following article, therefore, will discuss only the operation of industrial trucks, tractors and trailers, although portable hoists and conveyors really should work hand in hand, to show a saving in operating cost as well as giving greater speed and capacity.

The interest taken in the application of these little freight carriers to the task of handling all classes of material is growing rapidly each day, and as the automobile is fast supplanting the horse-drawn vehicle so will these electric stevedores supersede the hand trucks.

New York, the largest and busiest city in the world, is the most poorly equipped with freight-handling machines. More than half the commerce of the United States passes through New York, being distributed on the docks and piers and loaded from train to ship, or ship to train. In New York City there are at the present time less than 90 electric industrial trucks of about two tons' capacity, and not one single tractor, although the industrials are used as such. By far the greater portion of freight is handled by hand trucks.

Human power still reigns supreme in the carting of freight. Men are plentiful and are willing to work for a moderate wage. They are more or less shiftless, not overfond of this class of work, and are very unreliable; yet the longshoreman has always been a factor at the docks, and doubtless will be for a long time to come.

* Power Bureau, the New York Edison Company, New York.



Causes of Additional Expense Charged to Handling of Freight by Electric Stevedores

It is necessary to slow down loaded truck before it reaches gang planks to save breaking steering knuckle and battery jar. Freight tied on to prevent it from being shaken off truck. Inclines too short and steep and too narrow to allow trucks to pass.



Loading Merchandise Into Railroad Cars on Car Floats. Note Short Planks at Approach to Float Platform and Small Steel Plate at Entrance to Box Car

Yet with the close of the present war many, no doubt, will return to their native lands to engage in reconstruction, manufacture and farming. Shipping will certainly continue, longshoremen or no longshoremen, and the terminals will be unprepared to cope with the situation unless provision is made while the opportunity is at hand.

There are many who have no electric stevedores at present who say, "They may work to advantage on So & So's pier, but they cannot handle the class of freight we receive or ship." There are certain others who have tried industrial trucks and found them unsuccessful. There are still many skeptical people who, in a spirit of watchful waiting, are waiting to profit by the experiments and experiences of others. As to that class, which having tried the trucks and found them wanting, certain parts of this article are particularly dedicated. For it will probably be found that the principal reason for the so-called failure was a lack of helpfulness on the part of those in charge of the trucks.

Industrial trucks have a capacity of from one to two tons at a speed of about seven miles per hour. This is apparently forgotten when heavy loads are to be moved. Two to four tons are often placed on the platform or on a trailer, and the truck is called upon to "get away with it." The result is that long before the day is over the truck has lost its power and "pep." The storage batteries have been used up.

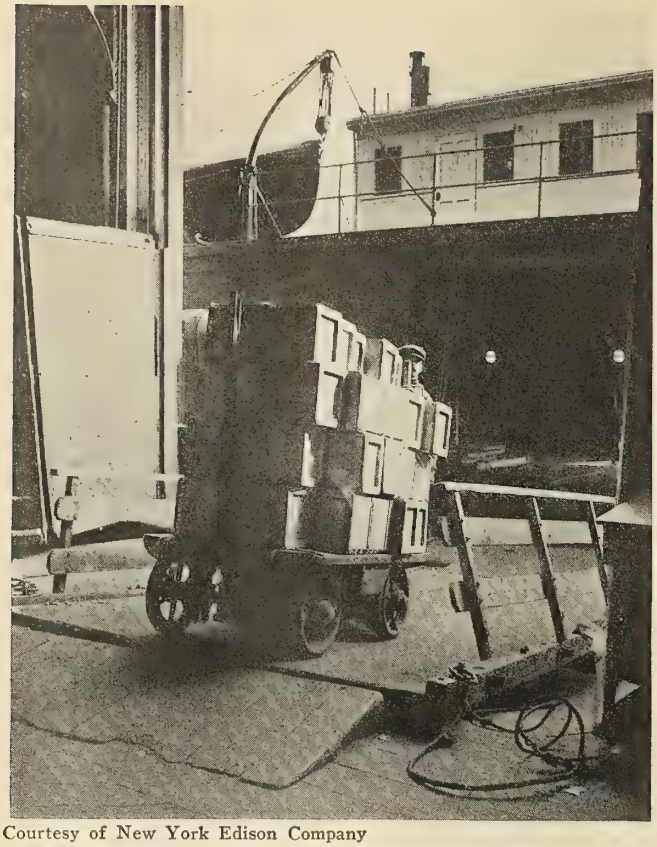


Use of Short Platform Trucks. Portable Scales Moved from Place to Place to Weigh Incoming Freight



Courtesy of New York Edison Company

Addition of Permanently Located Scales. False Platforms Raised Up Close to Ceiling After Freight is Removed. Short Platform Trucks Replaced by Trucks with Larger Platforms



Courtesy of New York Edison Company

Industrial Trucks Carrying Loads From Boat to Pier. Inclines Are Rather Steep and Approaches Abrupt

Then, too, there are the joy riders, who, having business at one end or the other of the pier, commandeer a truck to save walking. This may be all well and good when there is a load going their way, but deliberately to take a machine away from its work adds expense to the handling of freight, consumes useful energy from the storage battery and produces no adequate return.

As bad as the joy rider is the smart operator who tries to make the fastest time, whether with a load or traveling light. He comes racing down the pier and within a few feet of his destination jams on the brakes and makes a beautiful short stop. He is the one who also tries to skid around, especially when the pier surface is wet, to save changing his position or reversing the truck. He is the one who wears out the brakes, wears and tears the tires, overheats and sometimes burns out the motor, and runs down the storage battery. Is it any wonder, then, that the owners, not knowing of this abuse, condemn the electric trucks, saying they cost too much to operate and the upkeep charges are too great for the amount of work they accomplish?

Let us study the different classes of piers separately, considering first the railroad piers.

Equipment of Railroad Piers

The gangplanks, which are used to connect the car float platforms with the bulkhead sheds, are in many cases too short, making an extremely steep incline, and too narrow to allow hand trucks to pass one another. The ends of these gangplanks could be finished off at a more gradual taper, while thin iron plates securely fastened would afford ample protection to the ends of the boards.

The platforms on car floats should be raised to a mean car floor level and the plates at the door openings should be wider and cut at either 30 or 45 degrees, so a truck could go in or out without the ever-present danger of running off the plate. Cars should be shifted on floats so that the uprights, supporting the roof over the platform, would not come near the car door.

To carry out these recommendations would not cost much and would aid materially as well as financially in the handling of freight.

While the application of the industrial truck for freight handling to and from cars apparently has not met with much success in New York, in other cities they are used to great advantage. At present there are only four electric trucks used for this class of work. They are helping the situation, although they were never meant for such service. They are of the low-slung type, and when going over incline planks or uneven surfaces usually hit and bend, or break the steering knuckles, break the battery jars, or throw the steering lever out of the operator's hand. This particular type of steering apparatus—push and pull in a horizontal, instead of a vertical, direction—causes undue strains on the driver, catches in obstructions, and has been the cause of several injuries.

What, then, could be used to handle this class of freight?

Industrial trucks carrying from one to two tons, having a platform from 3 to 4 feet wide and a wheel tread from 2 to 3½ feet, could be loaded with freight, and, if kept within a width of 4 feet, could easily pass another truck with a similar load.

Tractors and Trailers Increase Capacity

Tractors having a capacity of from 2 to 6 tons and a width of from 3 to 3¼ feet could be used to great advantage for handling material to and from cars. These sturdy tractors pull from three to six trailers having a capacity of from 1,200 to 6,000 pounds each. The platforms measure from 2 by 3 to 3 by 8 feet. Two or three tractors could keep up a continuous flow of freight, the idea being to allow from nine to eighteen trailers to each tractor, depending on its capacity. While one-third are being loaded, one-third are in transit and the other third are being unloaded. Trailers could be dropped off at whatever car desired, where men would push them inside to unload or load, leaving the platforms clear for traffic. Very little time or money is saved by having the industrial trucks run into the box cars.

The loading and unloading of freight from cars to pier, especially at high or low tide, is by no means an easy problem to solve. Planks are laid and the incline is usually too steep for one man with a hand truck to negotiate. Planks should be built to flare out from the car door, be much longer, well supported and at least be wide enough for two trucks to pass.

The tractors could again be used to haul freight on trailers and push them up the inclines. The trailers for this class of work should be somewhat different from



Tractor Hauling Four Trailers Loaded with 4 Tons of Sugar



Application of Tractor and Trailers to Handling of Package Freight. This Type of Trailer Works to Good Advantage on Even Surfaces, but Is Not Applicable to Inclines Due to Platform Clearances



Trucks Carrying Freight to and From Box Cars. The Platforms Are Large Enough to Allow Trucks to Maneuver. Car Floor Is Level with Pier Floor

those at present on the market. They should be equipped with ball or roller bearings, wheels with either rubber tires, some resilient material, or perhaps tension and recoil springs, brakes and steering apparatus. The many advantages are apparent.

Piers for River and Sound Steamers

Let us consider next the piers occupied by river and sound steamships. These terminals are rapidly being equipped with industrial trucks, although some favor the tractors and trailers. The handling of package freight by any new method has been a bugbear to a great many people; still there are those who are devoting a great deal of time investigating and experimenting, and before long the difficulties will be overcome.

Bulkhead sheds at present are inadequate for handling the enormous quantity of freight that passes through each day. Some have additional platforms on which to store material when not quite ready for shipment, or until hand or industrial trucks can cart it away. After the freight is removed from these platforms, they are hoisted up close to the ceiling, out of the way. These have been superseded in some cases by smaller platforms, built at the same height above the floor as the industrial trucks, and furnished with castors. Instead of raising these, after material is removed they are taken to a convenient spot for future use. This change has led to many new ideas.



Courtesy of New York Edison Company

Loading Freight From Wagons to Electric Trucks on "the Farm." By This Method Part of the Congestion Is Relieved

Let us follow one box from the time it is received to the time it is put on board the steamship and see how many handlings it receives.

First the wagon delivers it to the receiving platform; second, it is moved over to the scales, where it is weighed, size taken, checked and receipt given; third, it is shifted to the false platform; fourth, loaded on the industrial truck, and fifth, from the industrial truck to stowing place on board the boat. Sometimes it is taken down the pier and left to await the arrival of the boat, which adds two more handlings, namely, unloading and loading on the truck. From five to seven times this box, or package of freight, is juggled around.

Application of Trailers

A proposition which would save this handling and rehandling of freight is the application of tractors and trailers similar to those previously mentioned. Instead of using the false platforms, put trailers there. This would save from two to four handlings. Tractors have a greater load-carrying ability and can haul from one to six tons of material on trailers. There is an ever-increasing belief that loaded trailers will be run on board the steamships and left there, so that when the boat lands at the other end of her journey these same loaded trailers can be run off, thereby saving the same amount of handling as spoken of before. The objections to such procedure are the space lost under the body of the trailer and the erecting of false floors over the main steamboat deck. There is no doubt but that freight could be loaded and unloaded much more rapidly, which means that boats could sail at more frequent intervals. This is where the money is made and is well worth serious consideration.

At present the farms, or space in front of the bulkhead sheds, are used for the storage of material, for wagons to unload either to industrial or hand trucks, or for wagons waiting their turn to go on the pier. It is well to keep as many wagons off the pier as possible; they take up space, block traffic, wear out the pier surface, and are in general a nuisance. If the bulkhead sheds are not large enough to receive the freight on its arrival, portable or permanent receiving stations can be located on the farm, duplicating those inside the shed.

Repairs to pier floors are made in a most unsatisfactory manner. If a plank has fulfilled its mission and is to be replaced, a 2-inch or 3-inch board is put down, where a 1½-inch plank would make the surface even. The edges

are poorly beveled, which causes a hard jolt in passing trucks.

Pier entrances in some cases are paved with unevenly laid cobblestones. Imagine anything worse than running over such surfaces. A thin mixture of concrete could be used to fill up the crevices, or at least a part could be laid out for trucking.

A little thoughtfulness on the above points would aid materially the speedy handling of freight and at the same time would reduce damage not only to the freight, but to the truck and operator as well.

There are at present thirty-six industrial trucks operating on piers occupied by river and sound steamship companies, and before long there will be several tractors used for the handling of this class of shipments.

Next are the piers occupied by coastwise and transatlantic steamship companies. These piers have the largest equipment of industrial trucks; about forty-five being in operation at the present time, although many are giving the tractor and trailer proposition serious consideration.

Industrial trucks rarely carry freight through the side ports of the ship entering the port of New York. The ports are too small and are either too high or too low from the dock level to allow for such procedure.

The loads are usually lowered from the ship to the industrial truck, and then carried to various places on the pier or farm. The use of trailers, at the present time, attached to trucks shows the desirability of tractors for certain classes of bulk material. There are many commodities that could be carried on the truck's back, but are given to the men. It is, indeed, a sad sight to see from 200 to 300 men burdened with heavy bags of material on their heads and shoulders, struggling in and out, then up inclined planks to deposit their loads on one of the various piles.

Sorting platforms could be placed where the cargoes are landed and from there loaded on waiting trailers which would be picked up by tractors and taken to their respective places. Here a portable piling machine could be used to great advantage.

Better use should be made of the bulkhead sheds. Instead of placing storerooms and repair shops along this space, let the teams use it for discharging or receiving freight.

Old-fashioned "dollies," without roller or ball bearings (usually the iron bearings are so worn that the wheels wobble in every direction), constructed of heavy lumber, and weighing so much that it is about all a man can do to move them, are coupled to an industrial truck, which consumes useful energy in overcoming friction, to say nothing about the tracking qualities. Here a well-built trailer would carry a much heavier load more speedily and at a greater saving in cost.

A very optimistic spirit exists among the members of coastwise and transatlantic steamship companies, and more credit should be given them for the way they have co-operated with truck manufacturers to show the electric stevedores to their best efficiency.

The above cases are a few of the many obstructions that impede the progress of electric stevedores. If they were remedied, they would aid the many companies in relieving the congestion that exists on the docks and piers of New York City. The building of two-story sheds, so that freight could be unloaded from the ships on the upper floor, and loaded on the lower floor, would also expedite the handling of cargoes.

There are a great many tenements and old buildings opposite the docks and piers which could be purchased by the railroads and steamship companies, and modern warehouses erected. This would remove a large quantity of freight that litters up the piers, and would save carting expense to and from warehouses, as is now the case.

In view of the present and future conditions of the terminals, more thought and consideration should be given to the application of "industrial trucks and tractors and trailers," to help solve the problem of handling freight.

Portable Loading and Unloading Machines for Marine Terminals

Application of "Brown-Portable" Machines to Wide Variety of Uses in Loading and Unloading Package Freight

BY HARWOOD FROST *

One of the most costly items of transportation, and one that is not likely to be always taken into serious account by the consumer, is the expense of loading, unloading, trucking and piling of the commodities during their passage from producer to consumer. The packages are piled, taken down and repiled in warehouses and on docks; they are loaded and unloaded into and from cars, boats and wagons over and over, and much of this work is done today by ordinary derricks and trucks and by the same slow, expensive and unreliable hand methods that were used by the Egyptians of four or five thousand years ago. These antiquated methods and their consequent high costs in the handling of the commodities resulted in the development of the "Brown-Portable" line of portable and sectional elevating, piling, conveying, loading and unloading machinery for the economical handling of materials in any form of package.

In nearly all these branches of transportation of packed goods, "Brown-Portable" machines have proved of service: the elevators are used to pile the goods in storage to await shipment; the sectional conveyors carry them into warehouses and across wharves; the portable loading and unloading machines put them into cars, take them out of cars and out of barges in the rivers and put them into steamers.

For some years the use of these machines was confined to the grain industry of the Pacific coast, but during the past few years their use has been extended to the handling of all kinds of commodities and materials in bags, bales, cases, barrels, rolls and other forms of packages. They are now used in mills and warehouses to handle fertilizer, sugar, wool, hay, straw, cork, rice, cot-

* President, Brown Portable Elevator Company, Chicago, Ill.

ton, lime, oil, paper, feed, kegs of nails and bolts, spools of barb wire, rolls of fence wire, carpets and rugs, kegs of beer, cases of canned goods, cartons of glassware, and a great variety of other commodities, with an average saving over hand methods of from fifty to eighty-five percent.

The accompanying illustrations show a few interesting types of "Brown-Portable" machines recently installed in connection with freight handling to and from boats. These are suggestive of the wide flexibility of this class of machines, and show how their portability and their adaptability to local conditions make possible their successful use under circumstances where more cumbersome and expensive stationary equipments would prove useless.

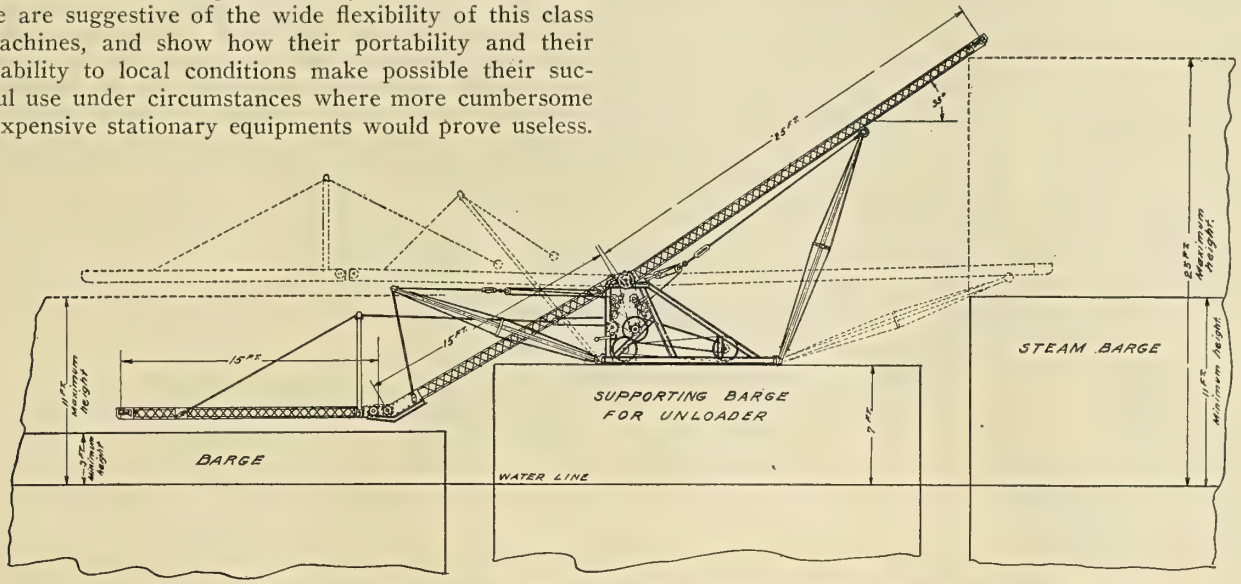


Fig. 1.—Three-Section Machine for Transferring Sacks of Grain From Barge to Steamer

Fig. 1 shows an unloader consisting of three sections, for transferring sacks of grain from a barge to the deck of a steamer. The lower carrier is jointed and all carriers are adjustable, by means of gearing operated by the motive power of the machine, to various heights and angles as may be necessary to take care of all variations in the height of either the barge or the steamer.

Fig. 2 shows an equipment made up of two parts used for transferring sacks from a floating elevator to cars on the shore. The grain is sacked at the top of the elevator and delivered to the receiving carrier of the unloader, then transferred across the intermediate supporting boat over two carriers and delivered to the car by means of a combined carrier and chute. This unloader is made in two sections so that the delivery carrier of the left-hand section can overlap the receiving carrier of the right-hand section, thus permitting the machine to be used on boats of different widths, and to adjust itself to the varying tides and heights of the boats.

Fig. 3 represents one of the latest and most useful types of carriers made by the Brown Portable Elevator Company. This equipment consists of several conveyor sections with power mounted on overhead frames, one of these conveyor sections being supported on a ramp, or hinged platform, which is adjustable to meet the requirements as to the varying heights of different boats. The conveyor carriages consist of steel axles, part being of a concave shape, and part a combination of straight axle and apron slats, the concave portion handling barrels, rolls, etc., the apron portion handling bags, boxes, bundles and loose pieces of hardware, etc., while bales of cotton

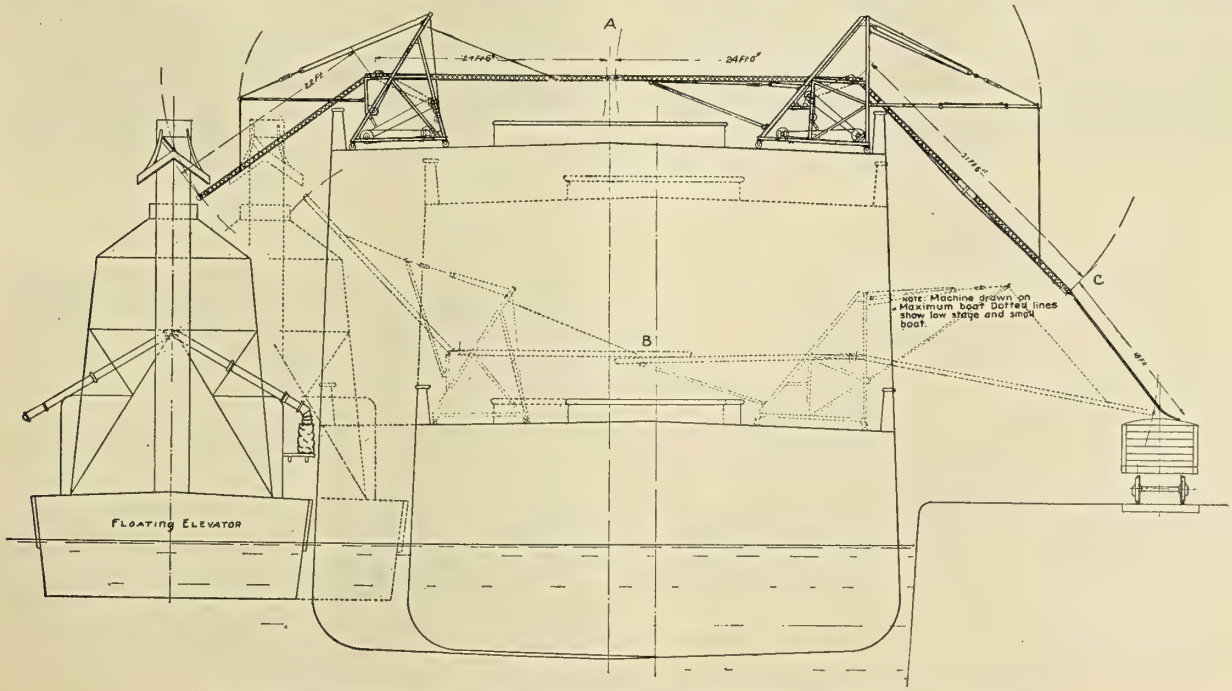


Fig. 2.—Apparatus for Transferring Sacks From Floating Elevator to Cars on Shore

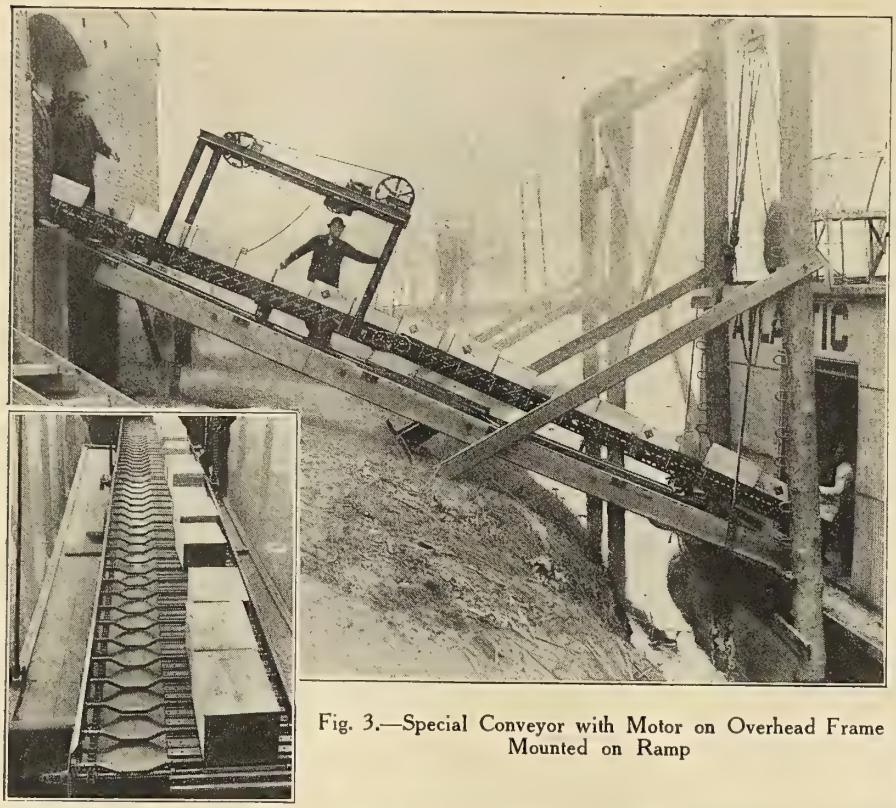


Fig. 3.—Special Conveyor with Motor on Overhead Frame Mounted on Ramp

and other bulky packages extend the full width of the conveyor. In its first trial in the unloading of a general cargo boat covering a great variety of commodities, this conveyor showed a reduction in the cost of handling of from 40 to 18 cents per ton.

Fig. 4 shows a special heavy type of portable conveyor made up of 18-foot sections used for both loading and unloading rolls of paper weighing 1,800 pounds. One portion of the machine is carried on the boat, while other sections remain at the receiving and discharging terminals. Either of these sections can be connected with the boat section in a very few minutes, and the heavy rolls loaded or unloaded at the rate of three per minute.

Another example consists of a portable unloading conveyor installed by the New Orleans Port Commission for handling bales of cotton, barrels of molasses, bags of sugar, coffee, etc. This conveyor receives the packages on the boat, carries them up a 20 percent incline to a distance of 115 feet, delivering them on electric trucks in the warehouse.

The "Brown-Portable" machines are made for many purposes and for the handling of a great variety of packages. Many instances could be cited of the special uses of these machines in the various industries, and of special combinations showing the elasticity and adaptability of the system, as well as the great saving in labor and time effected, but it is sufficient to say that there is scarcely a condition in the handling of goods in any form of package in and about marine terminal warehouses that cannot be met by the "B-P" system with an appreciable saving over the cost of handling the same goods by hand, derrick and truck.

Loss of the Memphis.—The United States armored cruiser *Memphis* was driven ashore at Santo Domingo City by a terrific ground swell during a sudden tropical storm late on the afternoon of August 30 and became a total wreck. Reports of the disaster indicate that the failure of the main steam pipe made it impossible to maneuver the ship away from the shore during the storm, and a number of the crew in the engine room staff were seriously injured. The *Memphis* was built by the William Cramp & Sons' Ship and Engine Building Company, Philadelphia, Pa., and was commissioned July 17, 1906, as the *Tennessee*. She was of 14,500 tons displacement.



Fig. 4 (a).—Section of Machine on Boat

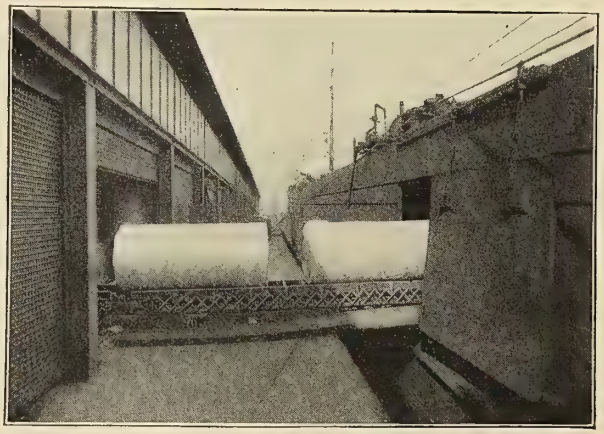


Fig. 4 (b).—Section From Boat to Pier

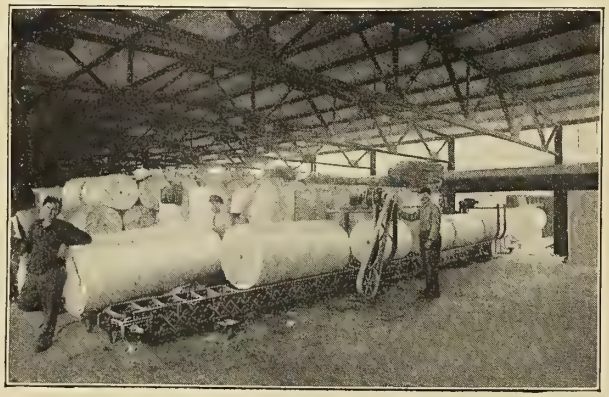


Fig. 4 (c).—Discharge Section in Pier Shed



Berths 1 and 2, Woolomootoo Bay, Sidney, New South Wales. Cargo or Transit Shed, 580 Feet by 60 Feet, Is For Assorting, Distributing and Temporary Storage Only

Competing Marine Terminals at Seaports

For Pre-eminence in Shipping, Seaports Must Provide Better Terminal Facilities—Lessons From European Cities

BY H. MC L. HARDING *

THE commerce of the United States for the year ending June, 1916, was $6,525,000,000 (£1,338,000,000). The exports increased $1,576,411 (£323,500) and the imports $541,025,000 (£111,000,000). These figures far exceed those of any country in the history of the world.

This enormous commerce is largely due to the war in Europe. Much of it, however, will remain if besides the low cost of production due to manufacturing in large quantities there be a low cost of water transportation with a correct physical preparation for the transference of the cargoes quickly and economically through the port terminals. Much of this commerce belongs to the United States on account of the raw material, the natural products from the farm, wood and mines, and the present wonderful facilities for manufacturing. All industries have received a great impulse during the last two years.

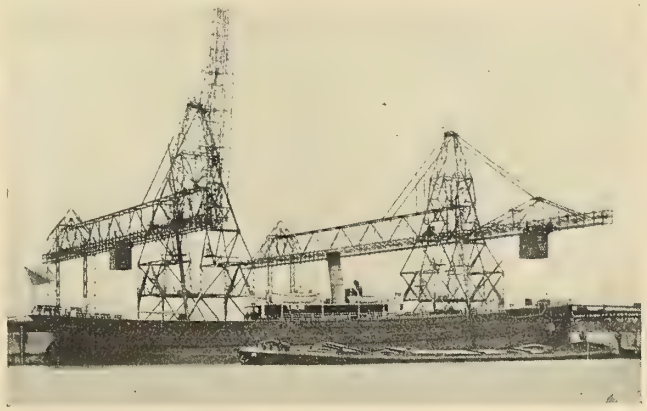
This still increasing commerce must pass through the gateways of port cities to reach the profitable markets of the world, which have been so lately developed and opened to the merchants and manufacturers of this country. Wherever the new gateways for the outflow and inflow of commerce are located, there will arise the richest and most populous cities of the United States. Those gateways will be pre-eminent which possess natural advantages, which can be developed most quickly and which have the fewest physical and political drawbacks to be overcome. The farther inland the port the less the rail haulage and the greater the possibilities.

For example, there can be no doubt as to the future of Albany, N. Y. This city has been handicapped in the past. Its manufacturers have not had the same opportunity that they would have had could ocean-going ships have been able to berth at the new concrete quays of this inland terminal. If a manufacturer there located desired to send goods to foreign countries, he must first pay the water or rail transportation expense to New York, and then the great terminal expenses of rehandling and of transference and probable barge transshipment at the port of New York, which port is by far the most expensive

* Consulting Engineer, New York City.



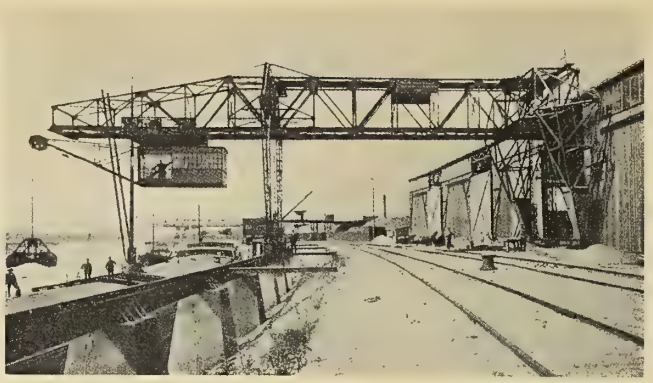
Pier Sheds at Port of Sydney, N. S. W., Set Back from Water's Edge. Movable Platforms Receive Goods for Second Story. Eight Gantry Cranes Have Been Ordered and Four Are Assembled



Plant for Handling All Kinds of Freight at European Port. Working Speeds, Lifting 240 Feet Per Minute; Trolley, 660 Feet Per Minute; Bridge, 80 Feet Per Minute



Traveling Electric Bridge with Trolley and Grab Bucket



Traveling Bridge with Jib Crane Beneath, Transferring Freight from Barge to Warehouse

harbor known to commerce. As these expenses are preliminary to the steamship rates, is it any wonder that his profit was greatly reduced? It does not require much business acumen to see that this condition could not continue long, even had there been no war to stimulate business and foreign commerce.

It can be asserted without contradiction that there must be many inland terminals if the greater proportion of the trade of the world is to be secured. Unless there be a change in port facilities, the greatest restraint of foreign trade will be the high expense of obtaining raw material and of the shipping of finished products to the markets of the world, and not a small proportion of this expense will be the terminal charges, especially when there are several rehandlings by manual labor, which is ever increasing. The high transportation cost does not signify that the railway rates are too high, but that on account of such long distances from many factories to a seaport with facilities and ships it is difficult for the merchants and manufacturers to expand according to their other opportunities. There should therefore be many new seaport terminals established as near as possible to the place of origin of the finished product.

What New York Lacks

It is said that the port of New York has at present superior facilities due to the railways and ships having terminals about the harbor. At all events, although it has expended millions for port improvements, it has a profit from its port operations of nearly ninety millions of dollars above all expenses. For Manhattan, of the city of New York, there may be the following criticisms.

The piers are not equipped with machinery so that the port can compete with foreign ports, as to economy and speed in the transference of cargoes. The above expense is more than double that of Germany for the same service. On this account, for which there is no logical reason, the manufacturers of the United States using the port of New York are at a great disadvantage and handicapped at the very beginning of their adventure into the field of foreign trade.

New York is acknowledged to be one of the most expensive ports of the world for the transshipment, transferring, handling and rehandling of freight, excepting only those which have not sufficient deep water to berth alongside quays or piers. When over 40,000 freight cars from all over the country have been held at one time on the New Jersey meadows for days, some from such remote points as Texas, and when such railroads as the Pennsylvania, the New York Central, the New York, New Haven & Hartford, and many other roads put an embargo on freight, refusing to accept any more goods or products for New York, the necessity for the development of many other ports needs no argument.

There are being built new terminals along the Atlantic and the Gulf of Mexico. Some of these will overtower the others. Which cities will have the greatest terminals?

The most successful city-owned port in each State with the best terminals will become the metropolis of such State. Such is almost universal history of great modern cities.

By what means can a city secure this pre-eminence and attract to itself the business from shippers, consignees and shipowners? How can it compete with existing ports and divide with such ports the ever-increasing new foreign commerce and obtain its share of the old?

The answer is not difficult. Provide better facilities than those of the older ports.

In what do these facilities consist?

Marine Terminal Facilities

1. That class of construction which will avoid interruption of commerce, either by fire, epidemics or by continual repairing—that is, make the quays or piers fireproof, rat proof and decay resisting. The quays and piers above mean low water should be of concrete construction. Such is the construction of the new quays at Beaumont, Tex.

2. Provide transferring and handling machinery which will be equal to, if not better than, that of any foreign port terminal. Such a port will be several times more efficient than any of the larger port cities of the United States. There is no doubt but that the American engineers as soon as the demand arises can and will surpass the best abroad. To secure a superiority over other competing ports, it is essential for such a city to be in the van in the construction of its terminals and in the installation of machinery, and not come trailing after nearby



Full Arch Gantry, Traveling Bridge and Grab Bucket. Jib Crane Above Bridge

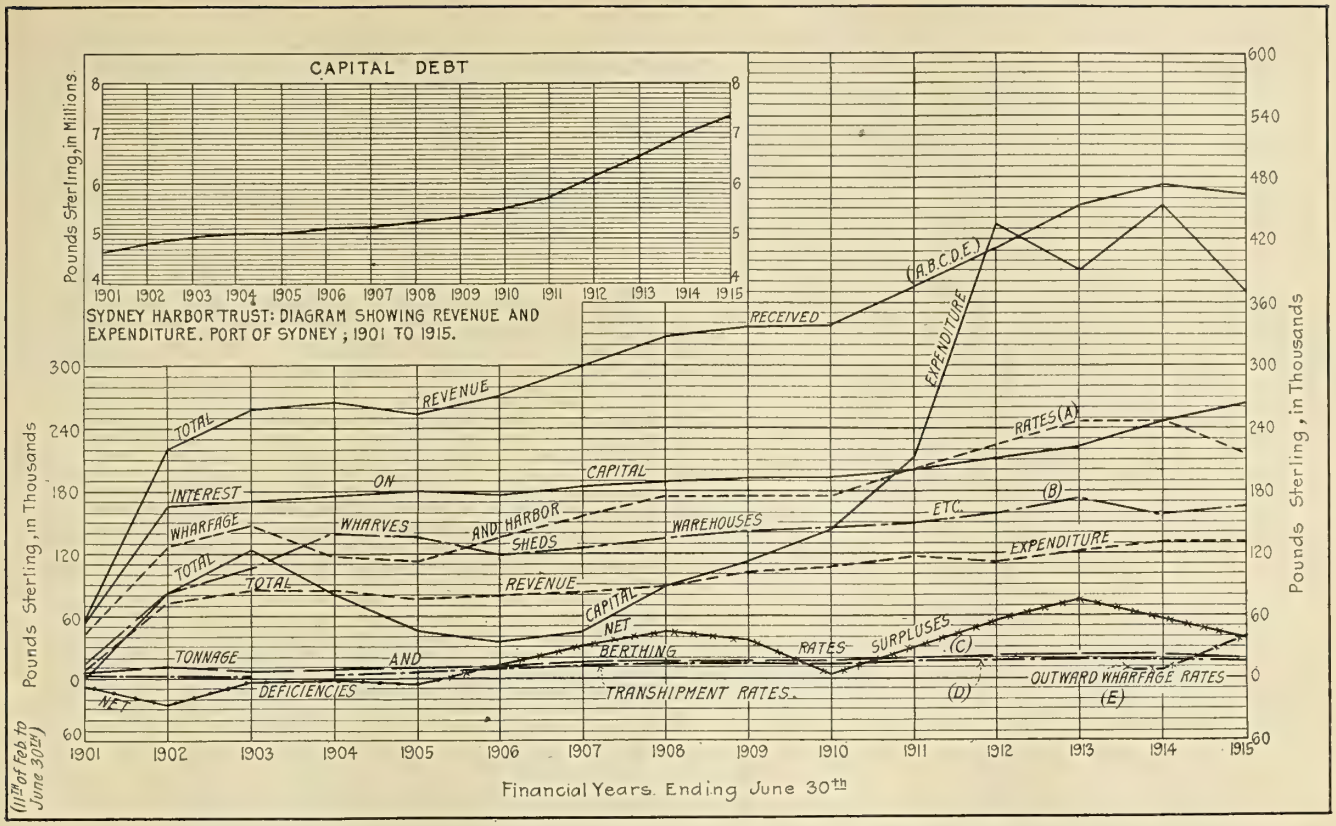


Diagram of Revenue, Expenditures, Surplus, Interest on Capital, Wharves, Wharfage, Warehouses, Tonnage Berthing and Rates at Port of Sidney, New South Wales

cities. The city which acts first will lead. Copying successful foreign ports and adapting their facilities to American conditions would put any American port far ahead in the competitive race.

3. It is necessary to have the closest railway co-ordination between ship and shore. Outbound goods must be directly loaded by machinery from car to ship and inbound goods from ship to shed.

4. Congestion at the point of deposition or elsewhere cannot be allowed, if speed of unloading is to be attained. It is this absence of congestion which comprises the superiority of the crane over the ship's winch.

5. There should be at the terminal not only steel sheds for assorting, distributing and tiering the cargoes, but also concrete warehouses for long storage.

There are many other terminal essentials, but only a few are given.

To help make the above description clearer, a few views of foreign ports are given, showing types of construction and the kind of equipment. It should never be forgotten that the investment in terminals is not a source of expense to a city, that is taxation, but besides the terminal being self-supporting, it is also a source of income. Its bonds are even in a more desirable class than water bonds. This does not apply to an incorrectly designed or poorly constructed terminal.

The following have been so universally accepted as to have become proverbs:

Commerce of City Dependent on its Terminals

The commercial future of a seaport city is dependent upon its terminal facilities.

Transportation efficiency to-day is a terminal problem, the main purpose of which is to secure an adequate development of terminal facilities for the transfer and handling of freight. That city which, through low terminal cost and high terminal speed reduces transportation expense, not only facilitates commerce but creates commerce and manufacture for the state and an enviable position for itself through its increasing population and prosperity.

The trade of a city is great as the city develops facilities for the flow of commerce through its gates, and its possible supremacy as a trade power depends upon its transportation efficiency.

This transportation efficiency has long been recognized by those countries which have been the leaders in foreign commerce, and their main purpose has been to obtain the utmost development of their terminals for economical and rapid transfer between vessel and shore. If a city will observe the above and possesses the following qualifications, the only limit to its growth is the growth of the nation.

The following are a few of the conditions necessary for a great industrial terminal, and then for the greater city:

Requisites of Industrial Terminal

1. A rich hinterland, rich in the possibilities of the products of the earth and of manufacturing.

2. Rail connections and a possible increase of such connections, including a terminal belt line and rail service to all parts of the terminal, to the city and to all territory tributary to the terminal.

3. A harbor and terminal site near the business center of the city for the industrial terminal, with control of possible future extensions.

4. A second location for a commercial or through terminal.

5. Low cost of harbor development proportional to that of other cities.

6. A navigable channel to the ocean.

7. A population, energetic and full of faith as to the future of their city, and as one unit as to its development in the fruits of which all will participate.

8. An important condition is to have a city-owned and city-controlled terminal. That is one that belongs exclusively to the people. This possession by the city of the terminal will render a city independent and prosperous, while a privately owned terminal will rather contribute loaves to the interests of the corporations, while the people may have the crumbs that fall from the table. There are too many examples of this.

9. Correctly designed piers and quays furnished with fireproof sheds and warehouses and completely and properly equipped with freight transferring, assorting and distributing machinery.

10. Near location for railway tracks for extensive car shifting, classifying and storage.

11. Land for manufacturing lofts, which should be under the control of the terminal.

A city is most favorably situated if possessed of all of these advantages, a combination difficult to be surpassed. Such a port should preserve and not part with its inherent rights. This is an important condition of supremacy.

Competition Between Terminal Ports

Competition between terminal ports should be of a most friendly nature, for the prosperity of each will redound to the advantage of the whole country. A fair and equitable competition will help both cities to advance and will unite them for a possible common cause and interest. The harbors on the River Rhine, Germany, are examples of what such competition will accomplish.

As is well known, proved by experience and established by many figures, quays, piers and sheds correctly planned and properly equipped with machinery for the freight movements without and within the sheds, will have from two to three times the transferring and handling capacity, than if not so designed and equipped.

This means that an investment of $250,000 (£51,300), including mechanical equipment, would be equivalent to an investment of about $750,000 (£153,700) not so equipped; or one foot of lineal quay wall frontage with machinery would be equal to about three feet without machinery; or if over one foot of frontage without mechanical appliances 150 tons can be transferred per annum, then with appliances at least 450 tons can be transferred in the same time. To secure these results with the attendant economy all congestion points must be eliminated.

The port terminals of the English colonies are often better types of construction with modern facilities, appliances and methods than those of Europe, and are in many respects more valuable for American engineers to study. It is better not to measure ourselves by our own measure—that is, by what has been done at some nearby terminal, but to be familiar with many ports in various countries, and thereby select from each the best.

In connection with the financial statements of these port expenses, as for lightships and lighthouses, beacons, buoys, dredging and the numerous other harbor charges which in the United States are borne by the Federal Government, these are all paid by the Harbor Commissioners from the port income. From such payments the ports of the United States are free.

In the analysis of the financial statement of the Port of Sydney, New South Wales, for the year ending June 30, 1915, are found facts of instructive interest. The revenues for the year were about $2,260,000 (£464,681). The working expenses, including commissioners' salaries, amount to $650,000 (£133,156). The ratio of working (operating) expenses to the gross receipts is only 28.65 percent. The capital investment to June 30, 1915, was $36,000,000 (£7,367,922). The rate of interest charge for the year was 3.6694 percent. The gross revenue yielded a return of 6.47 percent on the capital. The surplus revenue account and the sinking fund balance made the accumulated surpluses from February 11, 1901, as $1,740,000 (£353,472). The sinking fund is $865,000 (£177,012). This is the remainder after paying all operating expenses (salaries), interest, renewals and replacements.

The statement is thus given to show that port terminals in themselves form a good investment with most excellent security. The above figures and many others are given in detail from the beginning of the port to June, 1915, in the attached diagram and also the tonnage year by year. This diagram would be useful as a model and is a complete record in itself.

Besides the data from the port of Sydney, New South Wales, the reports from Columbo on the island of Ceylon, and those from Calcutta, Bombay, Madras, Rangoon, and other similar ports as to their functions, value of property, liability, powers, annual revenue and expenditure, can be studied to advantage. In their port development these cities have been obliged to investigate closely questions as to physical construction, equipment, investment, income and administration, the same as any American city would be obliged to do, when establishing new city terminals. In this general article it is possible to give only the names of such ports.

Conclusions

1. In the competition between port cities a city whose terminals are largely privately owned and controlled cannot successfully compete with a city whose terminals are owned, controlled and operated by the city and for the people.

2. Any city which hopes to secure its share of domestic and foreign commerce and to become the metropolis of its state must build permanent and fireproof quays and piers and such as will not be liable to an embargo on account of an epidemic.

3. No city and its hinterland, with its factories, mines and farms, can even hope to hold its present position if a large seaport, or to attain to its rightful heritage, unless it provides the terminal facilities, as sheds for temporary holding, and freight-moving machinery to attract the shippers, consignees and shipowners, and have available warehouses for long storage.

4. Its chances of holding even a rear position in the race for supremacy is small indeed unless it has complete co-ordination between rail and shore according to the best designs and plans.

5. No city can reach the goal of its ambition as a marine port terminal unless it offers all the mechanical appliances methods and facilities of the successful ports of the world.

Monthly Shipbuilding Report.—The Bureau of Navigation, Department of Commerce, reports 123 sailing, steam, gas and unrigged vessels of 50,739 gross tons built in the United States and officially numbered during the month of August. Nine of these vessels were steel steamships, aggregating 35,097 gross tons. The largest vessel built was the *D. G. Schofield,* of 8,651 gross tons, built for the Standard Oil Company at the Union Iron Works, San Francisco, Cal. Three other vessels of over 6,000 gross tons were completed during the month, including the *Emory L. Ford,* of 7,986 gross tons, built at Lorain, Ohio; the *Antwerpen,* 7,955 gross tons, built at Newport News, Va., and the *J. M. Danziger,* 6,487 gross tons, built at Philadelphia, Pa.

Freight Handling Through Unoccupied Terminal Space

Utilization of Hitherto Unused or Waste Space Over Storage Piles for Mechanical Transference of Freight

BY S. H. LIBBY *

The prime results desired in loading or discharging ships are:

1. Reduced manual labor.
2. Reduced time for loading and discharging.
3. Reduced port charges by reduced cost of handling between vessel's rail and storage.

All others are correlated or of secondary consideration. This is the result of the increasing scarcity of the class of labor heretofore utilized, the growing necessity of reducing the unproductive time in the life of the carrier itself, be it steamer, car, or what not, and because of the increasing value of wharf area.

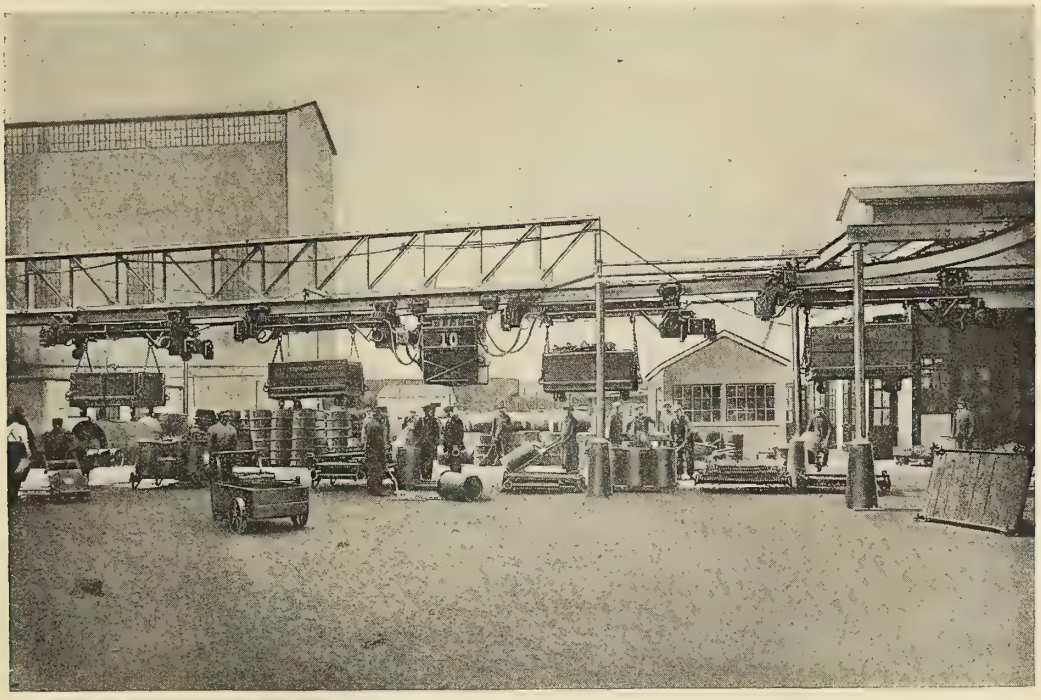
There is a growing scarcity of good muscle, and whatever the cause it need not be considered, as the fact that it exists is sufficient to bid us pause and give the subject serious consideration. Not only is the quality lacking, but the quantity as well, and the lack is felt in all industries where reliance has been placed on such labor in the past. This lack of labor calls for the use of such machinery on our river front as will utilize manual labor in the smallest degree, in fact it must be real muscle-saving machinery, of a character which will not only hoist or lower the freight between wharf and vessel's hold, but must transfer, tier and reclaim.

It must not only carry at a much less expenditure of what we might call muscle units, but it must do so at a greatly increased speed, reducing the time required per ton-foot between the vessel's rail and car or truck, and thus solve the second of the problems with which we must deal.

The reduction of time carries with it not only a reduction in cost of the actual handling of the cargo, but a reduction in cost of carrying by reducing the idle time of carrier, or the time during which it is in port and used as a warehouse only.

The increase in size and cost of ships makes it essential that everything be done in the way of transferring cargoes which will tend to decrease the time the ship remains in port. As the cargo vessel is built primarily as a carrier and not as a storage warehouse, it is of course necessary to reduce the time to a minimum during which it is used for storage—that is, waiting to load and discharge, and actual time of loading and discharging. Thus, too, the truck, freight car or whatever is to take the cargo to or from the dock must be kept performing its duty of carrying as much as possible in order to fulfil its economical function, and therefore must be loaded and discharged in the shortest possible space of time.

In order that the carriers of either class may be kept moving as much as possible without regard to the movement of the other, there must be an elastic medium or reservoir both ways between the two classes of carriers, and it must be supplied in the form of storage space, such a reservoir admitting of relieving the carrier of its load,



Hoists, Monorail Cranes and Electric Storage Battery Trucks for Handling Miscellaneous Freight

* Engineer, Sprague Electric Works, New York.

if the receiving carrier is not ready to take it, the wharf or pier with its shed acting as such a reservoir.

In these days, when conservation is such a frequent theme, although so little practiced, the utilization of unused or unoccupied space is a thing much to be desired. The fact that floor area costs something, due to first cost of land and buildings, and maintenance charges, is a real incentive to the conservation of space and to the utilization of the present unused space. What is the value of our floor space from a productive standpoint? That is, what is the shop cost of our storage per square foot of floor space?

Conserving Floor Space

Analysis will show that it is sufficiently large as to become an important factor governing the design of the terminal, and as the reservoir capacity is a necessity it must be provided at as small a cost as possible, both as to ground area which it occupies and the cost of storing and recovering the material. Every square foot of floor space used for transferring, which could be used for storing, if some other means were used, is a liability rather than an asset, for the fixed charges must be borne by the area which is used for storing. If we work out a ratio of the used to the unused space in such a plant, we would undoubtedly be astonished at results which will reduce our assets and increase our liabilities to an unbelievable extent.

In a port where cargoes are loaded, discharged and stored within a stone's throw of multi-storied office buildings, the same necessity for an economic use of the ground area would seem to exist where it is used for dock purposes. Terminals as generally observed to-day do not utilize more than 50 percent of the ground area in the storage of material, and this storage or reservoir must exist in order that the carrier may be on the move as much as possible.

How Wharf Area is Wasted

In nearly every case transference has to be accomplished by a means which calls for the use of 50 percent of the wharf area for its accomplishment, leaving a like amount for storage, resulting in a gross waste of wharf area, and in many cases the means employed seem based on the general idea that the more muscle units used the better the result, thus insuring the stay of the ship in port, where it is earning nothing, for the longest possible time.

Taking the unused floor area occupied by gangways left for trucking in conjunction with the unoccupied headroom due to difficulty in piling, and the unoccupied space runs in most cases to more than 75 percent of the total space occupied by the shed. If, now, we can accomplish transference through part of the unoccupied space, and also pile by means of our handling apparatus, this condition might be reversed, the unoccupied space being reduced to 25 percent and the capacity of the building be increased threefold.

Thus the method for increasing the capacity of the present floor area which would naturally first present itself would be to accomplish the movement of the material through unoccupied or useless space and the increased speed which is so desirable would also be accomplished by the rapid movement of small units through such space.

In order to bring this increased reservoir capacity of ground area to its maximum the useless or unstored space will be reduced to a minimum by utilizing the space over the stored material for moving material to and from the rail of the ship, and leaving as unused or unstored space only sufficient floor area in aisles to admit of parts of storage piles being reached, but with no space left for moving the material between the piles. This not only calls for all lateral movement taking place over the tops of the storage piles, but must admit of any part of the ground area occupied by the shed being reached by the transferring apparatus.

By utilizing for transference the useless or waste space over the storage piles the material may not only be moved more rapidly, but, if the system be correctly designed, it may be taken in a more nearly direct line between receiving point and delivery point, which movement in itself constitutes a means whereby increased speed may result.

The advantages to be gained by utilizing the present unused space over the storage area for the transference of material are so many and so evident that the design of the most efficient marine terminal must of necessity include a system which would operate in that space and combine the area covering features of a bridge crane with the rapid, frequent, small unit movement of the monorail crane, and its use calls for not only the modification of our typical dock shed, but a radical modification in the system which now obtains, both clerically and as to supervision.

It has been said that "the immediate problems have to do with the installation of mechanical apparatus in present terminals," but the desired results cannot be obtained in that way, as the many trials and rejections attest, and until it is fully realized that not only must the apparatus be designed for the terminal, but the terminal for the apparatus, there will be a crying need for means whereby labor, time and cost of handling may be reduced at our port terminals.

Hunt Trucks, Tractors and Trailers

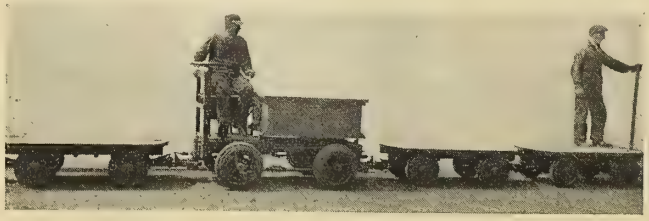
BY G. K. JENCKES *

THE enormous tonnage of freight being handled over the piers of the steamship companies and the difficulty of securing the necessary labor at a reasonable price, naturally brings to the attention of the owners the question of labor-saving devices to accomplish this work more expeditiously and cheaply. Many systems of machanical carriers have been suggested and tried with varying degrees of success, but the test of time has shown that the electric storage battery truck offers one of the best solutions thus far developed.

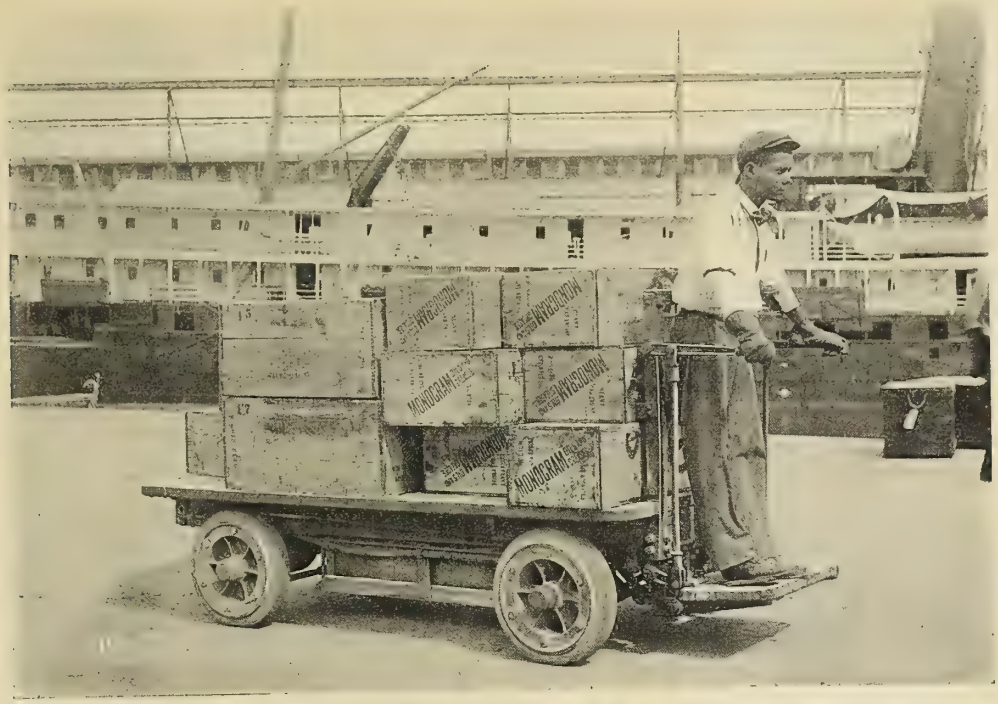
A brief analysis of the situation shows why this is so. One of the first things to contend with is the variation in the size and hatch arrangements of the steamers to be loaded and unloaded. This precludes the installation of fixed overhead carriers. Next the rise and fall of the tide complicates the situation so that carriers fixed in the vertical plane are rendered difficult or impossible to install.

Then there is the problem of handling a mixed cargo, which may be either in bulk, bags, barrels, bales or boxes.

* With the C. H. Hunt Company, Inc., West New Brighton, N. Y.



Hunt Tractor Pushing Two Trailers and Pulling One, the Whole Train Being Steered from Front Trailer



One of Fleet of Twenty-one Hunt Trucks used by U. S. Government at the Panama Canal

A conveyor to transport boxes of eggs is not well adapted to handle bales of cotton. Owing to the stowing of the cargo the material will always enter or leave the ship in a mixed fashion which prevents the use of different types of conveyors for different classes of goods.

When we take up the question of distribution of the freight on the piers we have reached perhaps the most important consideration of all, for a successful mechanical device to perform this service must be able to take the freight from any one point to any other point. This must be done without taking up valuable floor space which is available for storage purposes.

In brief, the keynote of the whole problem is flexibility. In the past this has been obtained by the two-wheel hand truck and is the only quality it has to warrant its continued use. Bearing in mind these facts, the substitution of a small power operated truck for the hand truck is a logical and rational development.

The above shows some of the reasons for the existence of the electric industrial truck, or, as it has been aptly termed, the "electric stevedore." This little machine, with a speed of around eight miles per hour and a carrying capacity of 4,000 pounds, enables one man to do the work of from eight to twelve men with hand trucks, depending on local conditions.

The accompanying illustrations show the type manufactured by the C. W. Hunt Company, Inc., West New Brighton, N. Y., in operation at various piers along the waterfront of New York harbor. These trucks, operated in fleets of from four to eighteen, have all paid for themselves in from four to six months' use.

As the familiarity of the users with possibilities of the electric truck has increased, new methods have gradually developed, the principal one of which has been the use of trailers to be drawn by the power unit. This is a particularly valuable arrangement when it is necessary to leave the load standing for any length of time. To meet this need the C. W. Hunt Company, Inc., has developed a trailer which is of unique design.

In order to secure economy of operation it is necessary for the power unit to pull several trailers. When this is done it is at once apparent that some method of construction must be used which will cause the trailers to follow in the tracks of the leading unit of the train. This has been accomplished with a fair degree of success by some manufacturers by the use of flexible connections, such as chains, etc. However, a train like this cannot be backed up and is a dangerous thing to handle on steep grades, as it will crumple up.

The trailer which has been developed by the C. W. Hunt Company, Inc., is so constructed that a train can be operated in either direction at full speed and the individual units will at all times track with the leader. To realize the great advantages of this device one has but to watch a driver of a horse-drawn wagon, to the end of which is attached another wagon, try to back up.



Steamship Terminal Service at the Pacific Coast Steamship Company, Seattle, Wash.

Hoisting Equipment for Marine Terminals

Electric Monorail Hoists and Traveling Cranes Installed on Steamship Piers by Shepard Electric Crane and Hoist Company

ONE of the greatest difficulties in equipping existing terminals and freight houses with modern freight handling equipment is the fact that the overhead construction of the piers is not heavy enough to support the weights of a type of monorail hoist which is rugged enough to stand up under the hard work called for in this type of service. Another difficulty is that usually these buildings are comparatively low and there is not sufficient room for the installation of this type of apparatus.

It is strongly urged that in considering the extension of existing buildings the matter of handling the equipment be given serious thought and the manufacturers of hoisting equipment be given an opportunity to demonstrate the savings possible by the use of efficient freight handling equipment. The Shepard Electric Crane & Hoist Company, Montour Falls, N. Y., has made comparatively few extensive installations of such machinery in strictly marine terminals, but the company has had a great deal of experience in solving the freight handling problems of many of the industrial plants where the conditions to be met are fully as difficult to solve as in a marine terminal.

Floor-Operated Monorail Hoist

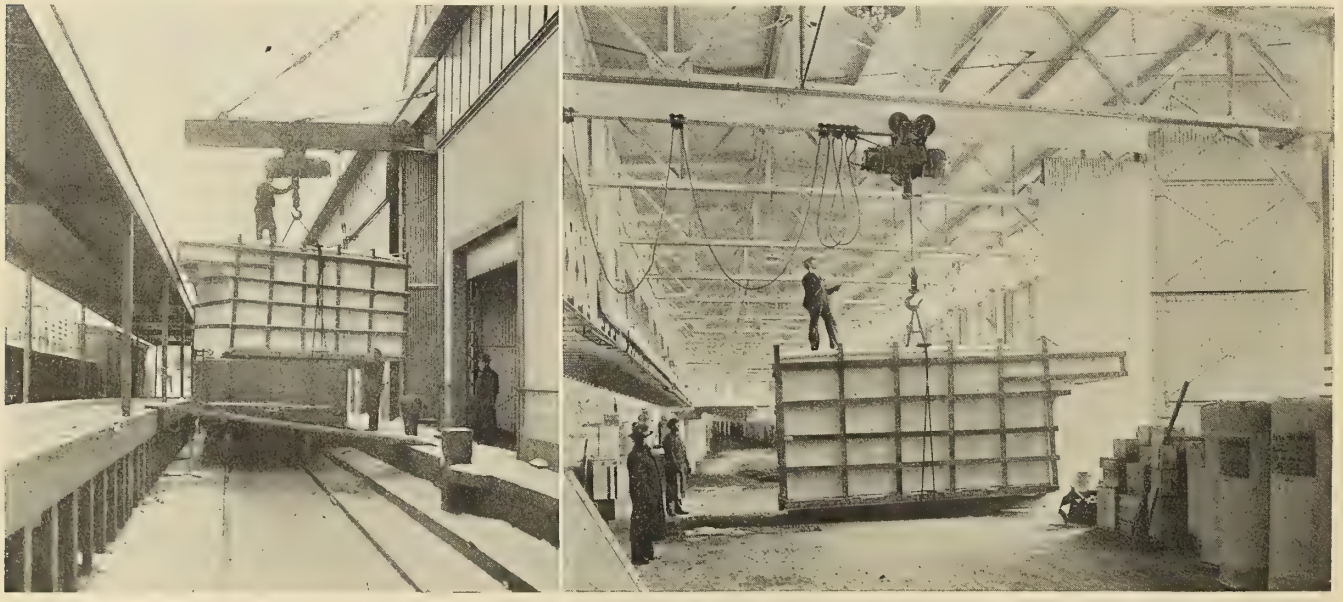
At one of the terminals of the Central Railroad of New Jersey, for instance, freight is brought to the pier by lighters and unloaded by a 10-ton floor-operated monorail electric hoist installed by the Shepard Electric Crane & Hoist Company, as shown in Figs. 1 and 2. The miscellaneous package freight is deposited from the lighter onto the deck of the pier and then trucked to storage space, whence it is loaded onto wagons for delivery about the city. The heavier articles are deposited directly on trucks from the hoist.

Fig. 3 shows three 2-motor floor-operated monorail electric hoists each of 3 tons capacity mounted on the upper deck of pier No. 6 of the Bush Terminal, Brooklyn, N. Y. These machines handle freight which is delivered to the pier directly from steamships. The material is brought beneath the hoist runway by electric trucks hauling a string of trailers, each trailer having a removable platform upon which the freight is piled. The electric truck leaves the trailers directly beneath the hoist runway and returns down the pier for another load. During the time when the truck is going after a second load the hoist operators remove from each trailer the platform upon which the freight is loaded. These platforms are lowered through the hatchway, as shown in the illustration, and deposited on automobile trucks, which run in on the main deck of the pier for distributing the freight to warehouses and other destinations.

Cage-Operated Monorail Hoist

At the plant of the J. Edward Ogden Company, Bayonne, N. J., a 2-ton capacity cage-operated monorail electric hoist, installed by the Shepard Company, handles material directly from the barges. As can be seen from Fig. 4, the material is picked up after it has been deposited on the end of the pier and then carried directly to the storehouse shown in the background. Cage-operated monorail hoists of the type installed here are especially recommended for freight handling. The machines are equipped with powerful motors, giving high speed both in the hoisting and traveling motions. When handled in conjunction with switches or transfer bridges this type of machine, it is claimed, insures the most economical handling of freight possible.

Another type of heavy equipment for handling bulk freight is shown in Figs. 5 and 6. This installation comprises six 3-trolley cage-controlled overhead electric traveling cranes, two transfer scale cranes and two floor-operated monorail hoists. This equipment was installed several years ago at the plant of the St. Lawrence Sugar Refining Company at Montreal, Canada. The plant is



Figs. 1 and 2.—Ten-Ton Floor-Operated Monorail Hoist Installed at Pier of Central Railroad of New Jersey

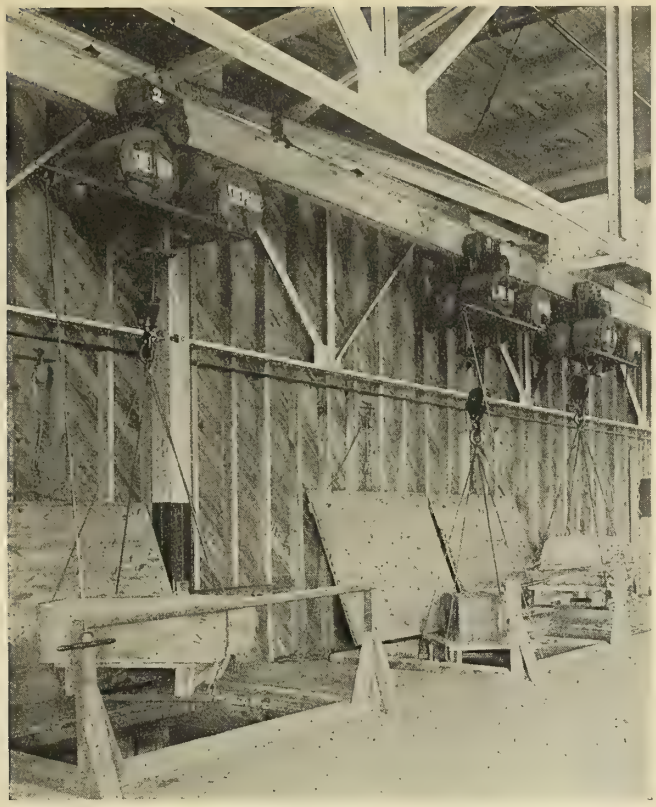


Fig. 3.—Two-Motor Electric Hoists at Bush Terminal Pier

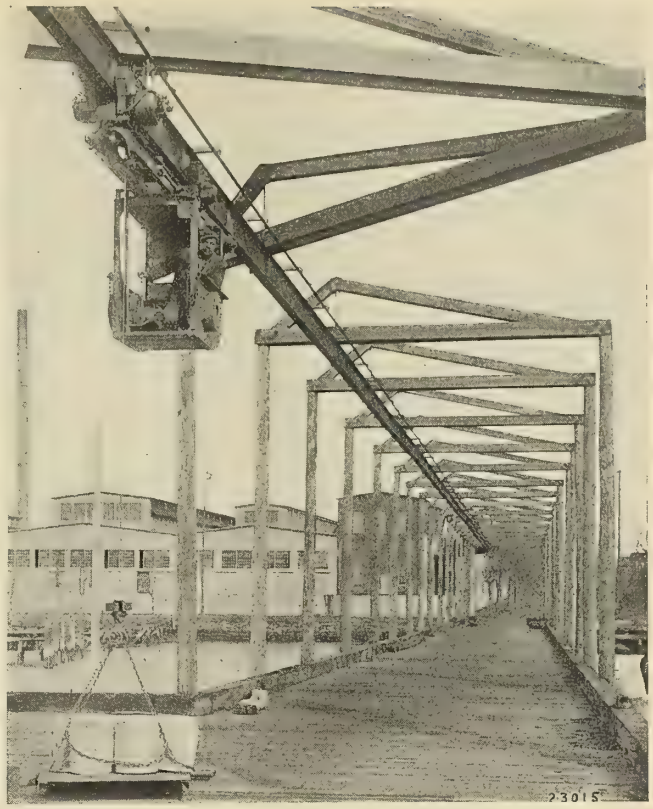
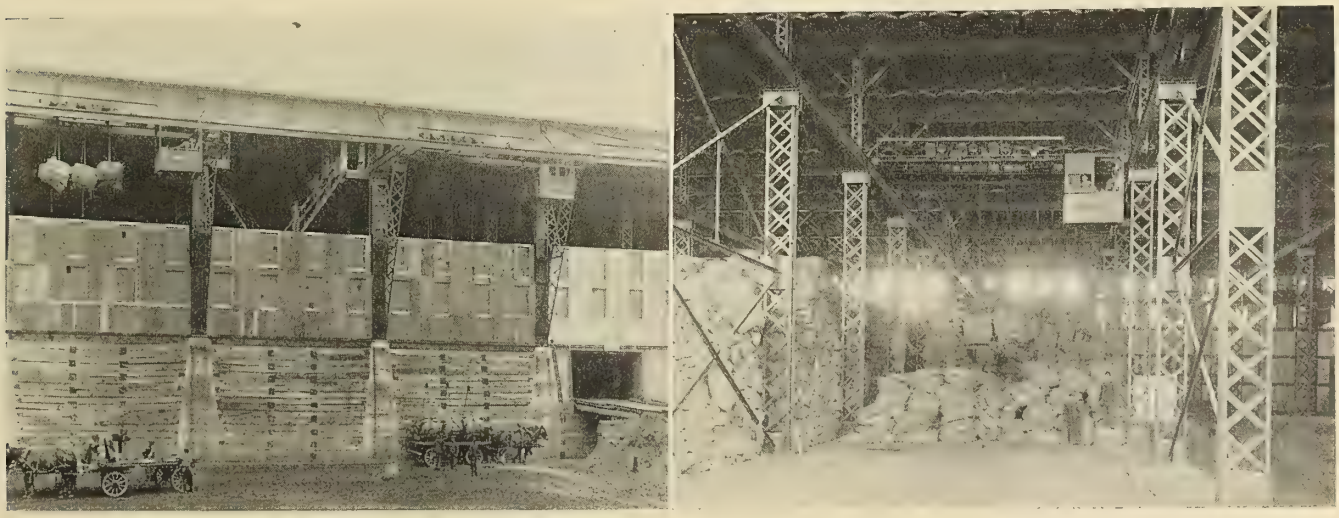


Fig. 4.—Two-ton Cage-Operated Monorail Hoist

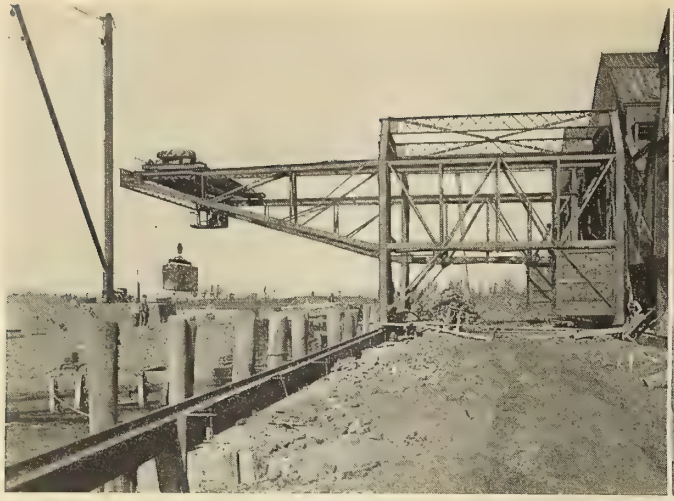
located on tide water, the bagged sugar being unloaded from ships directly onto trucks, as shown in Fig. 5. The bags are loaded on slings placed on the truck body, so that the overhead cranes can lower their hooks directly on to the pier, thus lifting an entire wagon load of sugar at one time. After the loads have been raised sufficiently to go into the opening under the crane runway, the crane is run into the building a few feet, where it runs on to the scale crane and, while the weighing process is under way, this scale crane is driven along the end of the building until it reaches the bay into which it is desired to deposit the bags of sugar. Fig. 6 clearly illustrates the method of unloading. This installation has been found very successful in operation, the handling cost having been reduced very greatly over the hand trucking method employed before the installation of the traveling cranes.

Figs. 7 and 8 illustrate the method employed by the Richmond Brick Company, Green Ridge, Staten Island, N. Y., in loading and unloading brick from barges. It will be seen by Fig. 7 that a gantry type structure is employed to enable the overhead traveling crane to run out over the barges. When it is desired to remove a barge load of brick from one of the storage buildings, the gantry is moved along its runway until the crane rails mounted on top of the gantry come in correct alinement with the crane rails of the building. When this is accomplished, the overhead traveling crane runs out on to the gantry and lowers a load of 5 tons of brick on to the barge, and repeats the process until the barge is fully loaded. When it is desired to unload the barge of bricks the process is of course reversed.

The particularly interesting feature of this installation



Figs. 5 and 6.—Hoisting Equipment at Tidewater Plant of St. Lawrence Sugar Refining Company, Montreal, Can.

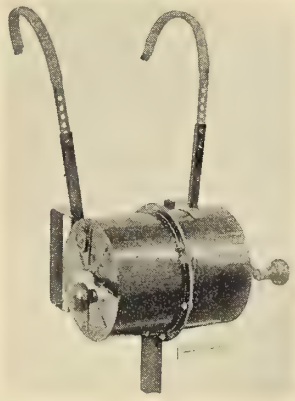




Figs. 7 and 8.—Equipment Used by Richmond Brick Company, Staten Island, N. Y., for Handling Brick

is the application of the gantry structure for transferring the traveling crane from one building to another. If this idea had not been developed, it would have been necessary to install an overhead traveling crane in each of the buildings, with a structure built out over the pier so that each crane might run out far enough to bring its load directly over the barrge.

The design of the Shepard apparatus is well adapted to the service required in marine terminal work, where unskilled labor is largely employed, as the cranes and hoists are as nearly fool-proof as it is possible to make this type of machinery. The design is such that standard units may be combined so as to meet the requirements of almost any special installation with standard apparatus.



Portable Controller

How Electricity is Harnessed to Terminal Work

Moving Freight by Electricity—Source of the Power—Generators, Transformers, Motors and Control Appliances—Methods of Braking—Storage Battery Trucks

BY ROBERT H. ROGERS *

ELECTRICITY has become almost the universal power for operating freight-handling machinery for both bulk and package freight—the only serious competitor being steam in some branches of bulk cargo handling machinery. The art of moving freight by machinery has advanced rapidly and the developments are as varied and numerous as this complicated and extensive work would indicate. Between ambitious electrical energy on the one hand and the great variety of work to be accomplished on the other, there is interposed an ingenious array of apparatus, devices and systems for the safe and sure harnessing of the power to the work.

Energy may be purchased from a large public service company or generated at or near the place of using by means of steam turbine generators, gas or oil engine driven generators or the like. The central station power is to be preferred principally on account of continuity of service; it is ready at any hour of day or night and breakdowns are almost an impossibility, due to resources in the way of spare machines, excess power and alternative circuits. At one of the greatest terminals on the American coast the accumulated shutdown for lack of power in four years was seven and a half minutes. The central station furnishing this power has certain major circuits which have not had a shutdown in twelve years.

When all things are considered, the cost of central power will almost always have the advantage and unless there are peculiar local conditions or some special consideration the purchased power is best, especially when all-night lighting is considered. The power available may be alternating current delivered at from 550 to 13,200 volts (with 2,300 volts probably the most common) or

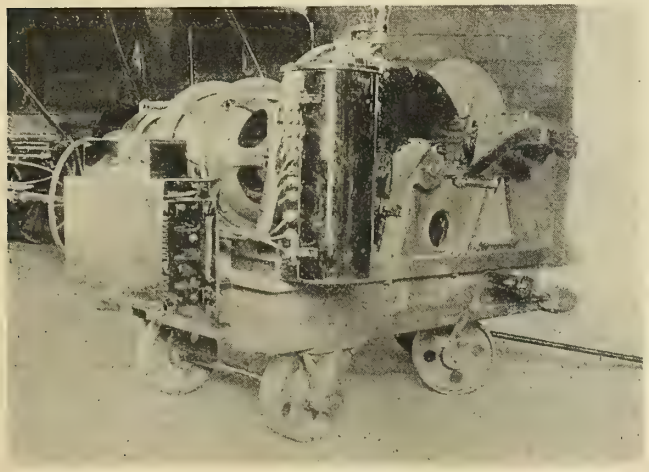
* Power and Mining Engineering Department, General Electric Company, Schenectady, N. Y.



Some Classes of Terminal Work Require the Interposition of a Storage Battery

direct current at from 230 to 600 volts. The alternating current has an additional characteristic in the number of reversals per second or cycles as it is called. This may be 25, 40 or 60 cycles, with an occasional region having 50 cycles. Again the alternating current may be made up of one, two or three strands, as it were, called phases, known as single phase, two phase or three phase. Direct current varies only in the voltage.

For safety it is not advisable to use the high alternating current voltages directly at the machines, and in some cases it is desirable to use direct current at the machines when only alternating is available, hence recourse is had to transformers and converters or motor-generator sets. The transformers step down the voltage to a convenient and safe value, while the converter or motor-generator changes the energy from alternating to direct, as desired. Direct current is usually used as delivered, except when low voltage is required for charging batteries, in which case a motor-generator set motors off the high voltage and generates the lower voltage required. When only a small quantity of direct current is required at low voltage, recourse may be had to a rectifier which changes alternating to direct current through the check valve action of an electric arc through mercury vapor.



Typical Dock Hoist, Showing Motor, Controller, Starting Resistance and Solenoid Brake

The motors used on alternating current lines are usually adapted to the phase and cycles available, though in some cases it is desirable to change from two to three phase, which is done by specially connected transformers. As a general thing the highest safe voltage is selected in order to keep down the cost of standing circuits as high voltage means low current and small wire for a given horsepower transmitted.

In order properly to safeguard the system, to measure the energy used and to distribute it conveniently, the public service cables (if direct current) are brought to a service station or panel which is enclosed in a cabinet and on which are mounted switches for manually opening the circuit, automatic circuit breakers for opening the circuit when an abnormal overload occurs—safety valves, in fact—and a meter for measuring the energy used. From here cables lead to a distributing panel, where a network of bus bars and switches break the main line up into lesser circuits leading to the various piers, warehouses, large machines, battery charging station, etc. Here the lighting circuits may be separated from the power circuits and separate meters installed to indicate lighting load, which usually takes a different rate. Following a circuit now to a specific pier, we will find another distributing panel which again subdivides the lines to various parts of the pier, as to elevators, to wall receptacles (for portable machinery), to the principal hoists or cranes, etc. If the

lighting circuit is taken off here it will be subdiveded into pier working lights, watchman's lights and office lights, and another circuit to receptacles where ships may attach hatch clusters.

In the case of an alternating current supply there will be interposed between the panels as above described and the public service lines a transformer house or substation containing the necessary transforming or converting apparatus for rendering the energy suitable for the purpose. Where large machines are installed which require a considerable amount of power, high voltage circuits may be taken to points near them where transformers are installed to reduce to a working voltage, thereby saving some cost in the copper necessary to get the energy to the machine.

Selection of Motors

With electrical energy available at the machine, we now turn to the motor which changes it to mechanical energy to perform the hard drudgery of freight handling which formerly wore out good men, cost more money and took more time and space. Motors are selected to meet the peculiar requirements of each type of machine and to operate on the energy that has been brought to their leads. The principal non-electrical characteristics of motors are:

(a) Speed, which, if high, makes a cheap, small motor, but requiring much gearing to get down to the speed required in the working parts of the machine driven. If low speed, the motor will be heavy and bulky and will cost less trouble, can be put close to the work to be done —i. e., having less gearing interposed, it works more efficiently.

(b) Mechanical strength. Proof against ordinary accident, mismanagement, weather and shocks. Some types need to be enclosed to a greater or less degree to attain this desirable feature, other precautions are highly specialized insulating materials, great security of internal fastenings and high factor of safety on all parts subject to strains.

(c) Starting and running characteristics. Some motors have very high starting power, others can pull but little until up to speed themselves; some motors hold their speed at any load, others rise and fall with every change in load, and some have a high flywheel characteristic which is undesirable if frequently started and stopped.

(d) Accessories. Among the common accessories are sliding bases and pulleys for belted motors, back geared shaft for slow speed gear drives, and enclosing covers of various types. An important adjunct in freight-handling machinery drives is the solenoid brake, a device which is held released while the motor is energized, but which instantly grips and stops the motor if the circuit is accidently or purposely broken. This device plays an important part in the manipulation of the motor and certain machines where a rapid cycle of operation prevails.

The above motor characteristics are only the most prominent ones, but these and the minor considerations make the selection of the proper motors a question not easy to answer, especially when insufficient data are known to cover all phases of the question.

The control systems and apparatus for motors leads into an intricate and ingenious field which has done more to intrench electric power securely than any other item. Electricity lends itself so readily to rapid and complicated manipulation that steam and hydraulic power are clumsy by comparison. Motors may be thrown "on the line" by a simple knife or snap switch, if their size and characteristics are such that they and the line can stand it. Larger motors require to be eased on by steps of some sort, as provided by starting rheostats, drum controllers or compensators, as the case may be. Now it is frequently desirable to vary a motor speed, and this is done on direct current machines by additional points on rheostat or drum controller by inserting resistance gradually in the field exciting circuit. Alternating current motors are not normally variable in this sense, but certain types can be varied by the insertion of resistances in the rotor circuit. Multi speed A. C. motors are available, however, and where the speeds are well chosen the control and operation are very satisfactory.

For very large motors, or where several motors have complicated related functions, the control may be magnetic—that is, the main circuits are opened and closed by magnetically operated contactors, which in turn are actuated by a minor circuit through the master manual controller. In a way the energy governs itself under the guidance of the master controller. This system has the added advantage of ease of manual operation, an important point where rapid cycles are carried out all day long. A further departure is the portable master controller which the operator carries about with him, the flexible cable giving him 100 feet radius of action if needed. This device allows the operator to stand where he can best see his work or to walk about following the loads, insuring the greatest safety and speed. By means of this portable controller signal men are dispensed with, and as two motors can be run by one operator a great labor saving follows.

The quick, safe and sure stopping of motions in freight-handling machinery is essential to fast work, just as modern fast trains are possible only because of highly developed brakes.

Method of Braking

There are several methods of braking in use, the most familiar being the foot or hand operated band brake. The solenoid brake, mounted so as to act directly on the motor shaft, is a very efficient stopping device, and has the additional element of being an automatic safety stop, for, should the current fail the brake acts and prevents further motion, such as overhauling by the load and the like

Dynamic braking makes use of the principle that a motor, if driven by an external force, becomes a generator and offers resistance to that force. The energy from the generator *pro tem.* is dissipated in a bank of resistance grids—i. e., they are heated and dispense the energy in that form. This allows of arranging a controller to give various degrees of braking as required, rather than all on or all off, as is the case with the solenoid brake. This method of braking does not wear out any bands, shoes or other surfaces and does not have to be adjusted to take up wear. However, a solenoid brake must be used to get a full stop. Another step in the braking art is regenerative braking, wherein the current generated by the reacting motor is of the proper voltage to allow of its being switched onto the main line, thus conserving energy, for this energy may now assist some other motor rather than to simply heating up some inert iron. This system is most highly developed in the electric locomotive, which in holding back a heavy train on a grade may turn as much as 2,100 kilowatts of useful energy back into the system to help the power house pull some other train up a grade.

In order to bring electricity to the work, it is necessary in some cases to break it off, as it were, to give the motors more freedom of motion. For such machines as industrial trucks (electric stevedores), portable cranes, electric tractors, commercial trucks, etc., storage batteries are used to furnish the energy which has been stored in them in the form of a chemical distortion which rights itself by de-

livering the required electricity when a circuit is formed.

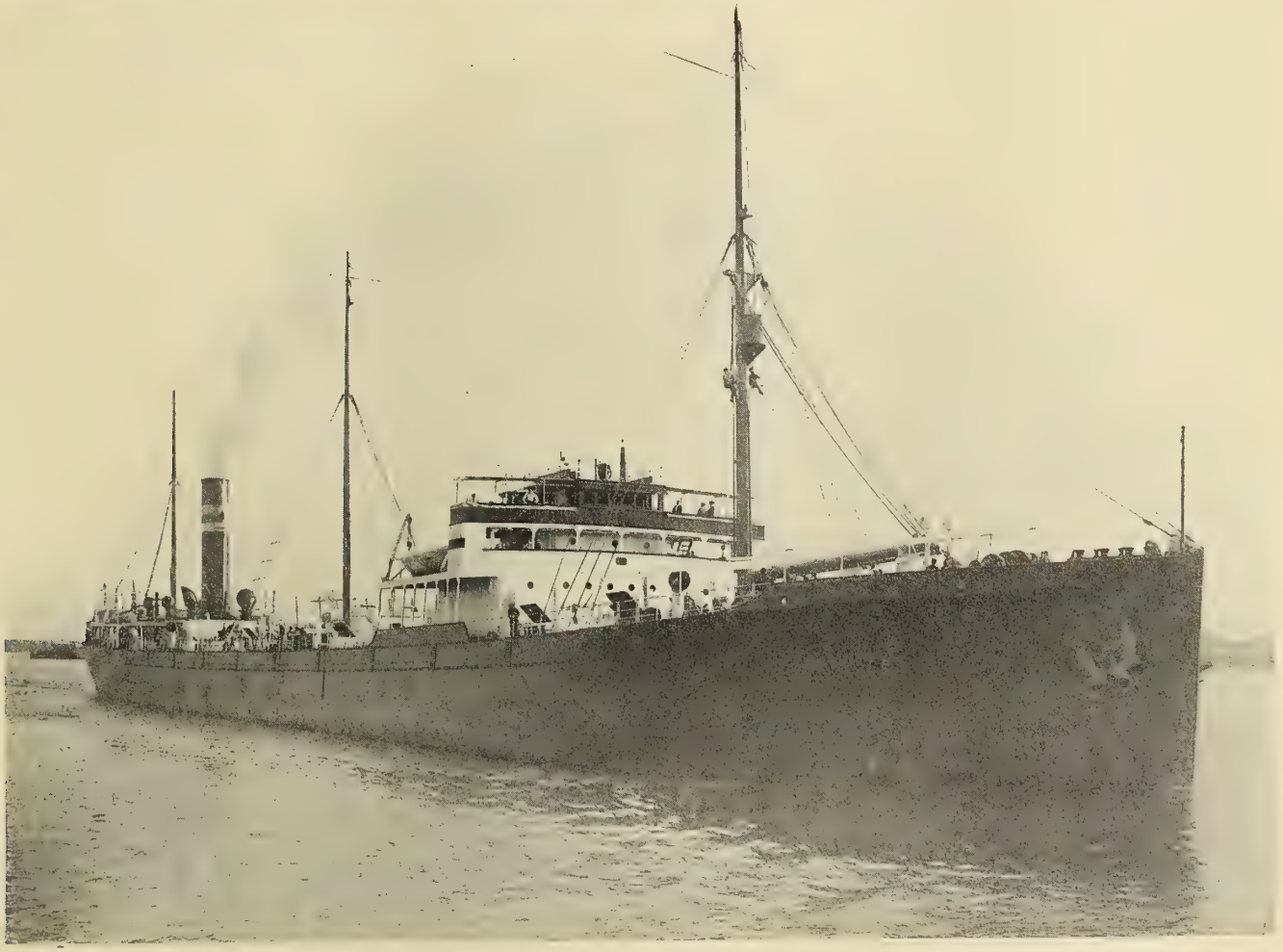
Storage batteries require about as many hours for charging as they can be used, and naturally take much more energy for charging than they can return. Two types are in common use—lead and Edison. The lead batteries are made up of metallic lead and litharge in a bath of diluted sulphuric acid, the whole contained in rubber or glass jars. The Edison battery is made up of iron and nickel in an alkali bath, the whole contained in steel cans. The general characteristics of the two types are similar, but differ widely in certain specific points.

Direct current must be had for charging storage batteries and at the correct voltage for the number and kind of cells to be charged. The proper care of batteries is essential both in charging and working them. Special motors have been designed to give the best results with the lowest possible drag on the batteries, which are, of course, limited in capacity at best. The control of such motors is simple, being confined to manually operated drum controllers. The braking is mechanical and not connected with the electrical system.

The proper lighting of terminals is coming in for engineering attention, and well it should, for where large numbers of men are engaged in handling heavy materials under pressure of modern traffic requirements, ample light well distributed is essential for safety of men and dispatch of freight. It would be hard to find equal area of equal activity so poorly and dangerously lighted as we find our terminals. In general, large numbers of units of small intensity are more desirable than few units of high candlepower. It is generally agreed that an illumination of .2 to .25 foot candles is the least that should be considered. Special lines, such as fruit and cotton, require special lighting for distinguishing grades or condition. Petty pilfering is much better discouraged by lights than by night watchmen, and as forty 150 candlepower lights can be operated on the wages of one night watchman, it is evident that the use of protective lights should be increased.

Terminal property, rolling and floating stock, and freight in transit are protected in large terminals and up-to-date piers by motor-driven fire pumps, specially designed and installed for operating under adverse conditions. The circuits and panels are so placed and protected that failure is practically impossible. Piping extends to all parts of the system with hose reels and sprinkler heads wherever needed.

There are so many variations in the energy available and so many kinds of work for the energy to do in terminals, piers and warehouses, that there is little wonder that so many kinds of motors, control systems, distributing apparatus and devices have been designed to tie them together. The proper selection of units to get safe, rapid and economical action on the part of the highly developed and complicated terminal machinery that now prevails, requires all the skill and technical training of engineers thoroughly familiar with the working conditions surrounding the handling and transfer of materials, and only the most hearty co-operation and interchange of ideas between the manufacturers of terminal machinery and the electrical engineers has made the modern terminal possible.



S. S. *Antwerpen*, Recently Built by the Newport News Shipbuilding & Dry Dock Company for the Rotterdam Petroleum Company, Reported Lost on Maiden Voyage. Length, 474 Feet 7 Inches; Beam, 60 Feet; Depth, 36 Feet 2 Inches; Deadweight Carrying Capacity, 11,500 Tons; Quadruple Expansion Engines, Scotch Boilers, Coal or Oil Fuel



Fig. 1.—Reinforced Concrete Ore Docks, Designed for Cleveland Furnace Company in 1906

Better Docks for Less Money

Reinforced Concrete Proves Ideal Material for Pier Construction—Comparison With Timber Structures

BY H. M. FARRAND *

BETTER docks for less money is rather a general term. Its value in meeting our present-day problem depends entirely on just how definite we can make this. Better docks mean well designed, efficiently laid out, permanent structures. Less money may, or may not, mean less first cost. It should be less total cost over a given number of years.

Of all traffic, of all burden carrying, water transportation costs the least. Docks, the points of contact between ship and land, have been, on the whole, rather expensive structures. Massive masonry abutment walls, requiring expensive foundation work, are high in first cost. Timber docks, open to rot and fire, are high in maintenance and low in service. Either type is expensive.

The Ideal Dock

Consider what an ideal dock should be: A loading floor with its outer margin adjacent to navigable water, sufficiently rigid to uphold any load placed on it, and able to withstand not only any impact shock from moving boats, but the outward thrust of banks, very often under heavy load.

The ideal dock should not obstruct the flow of the stream; it should not develop underscouring eddies and currents. It should be a dock, not a dam.

The ideal dock should be a permanent structure and its maintenance should be low. It should be rot, rust and fireproof. That dock is the ideal which gives you the maximum satisfactory dock service for the least total cost.

Necessity of Careful Design

The small amount of consideration that has been given to the careful design of permanent pier and wharf structures, when compared to the enormous amount of money invested in these structures, is surprising. Rule of thumb seems to have been the prevailing method employed heretofore, and it is only within recent years that owners have come to the conclusion that it is money wasted to build anything along this line without first securing the services of competent engineers who have had specialized experience and have made a study of this particular class of work.

Reinforced Concrete—The Ideal Material

Reinforced concrete is more than a material. It is an engineering force, making possible greater, more permanent achievement at less cost. Steel bridges, built to rust; wooden buildings, built to burn; timber docks, built to rot, are being replaced by concrete, built to last.

Consider now the ideal dock, and how reinforced concrete makes possible a better dock for less money.

Reinforced concrete develops strength without mass. With reinforced concrete an ideal dock, a rigid floor, carried out over the water and tied integrally with the shore

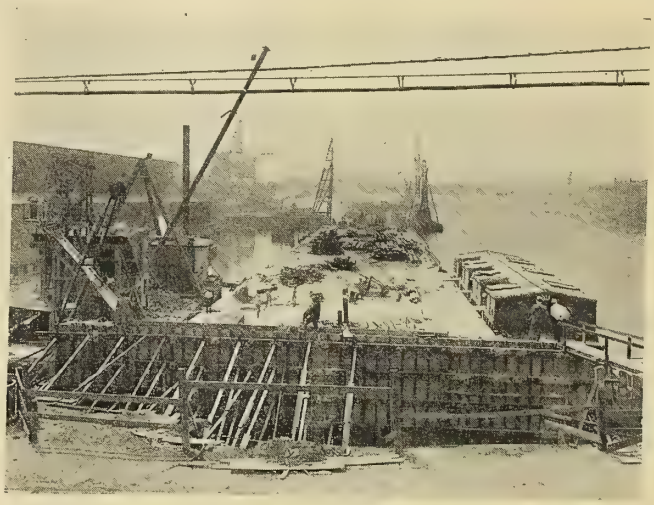


Fig. 2.—Concrete Coaling Pier Nearing Completion for the Pennsylvania R. R. at Canton, Md.

* Vice-President, Cleveland Dock Engineering Company, Cleveland, Ohio.

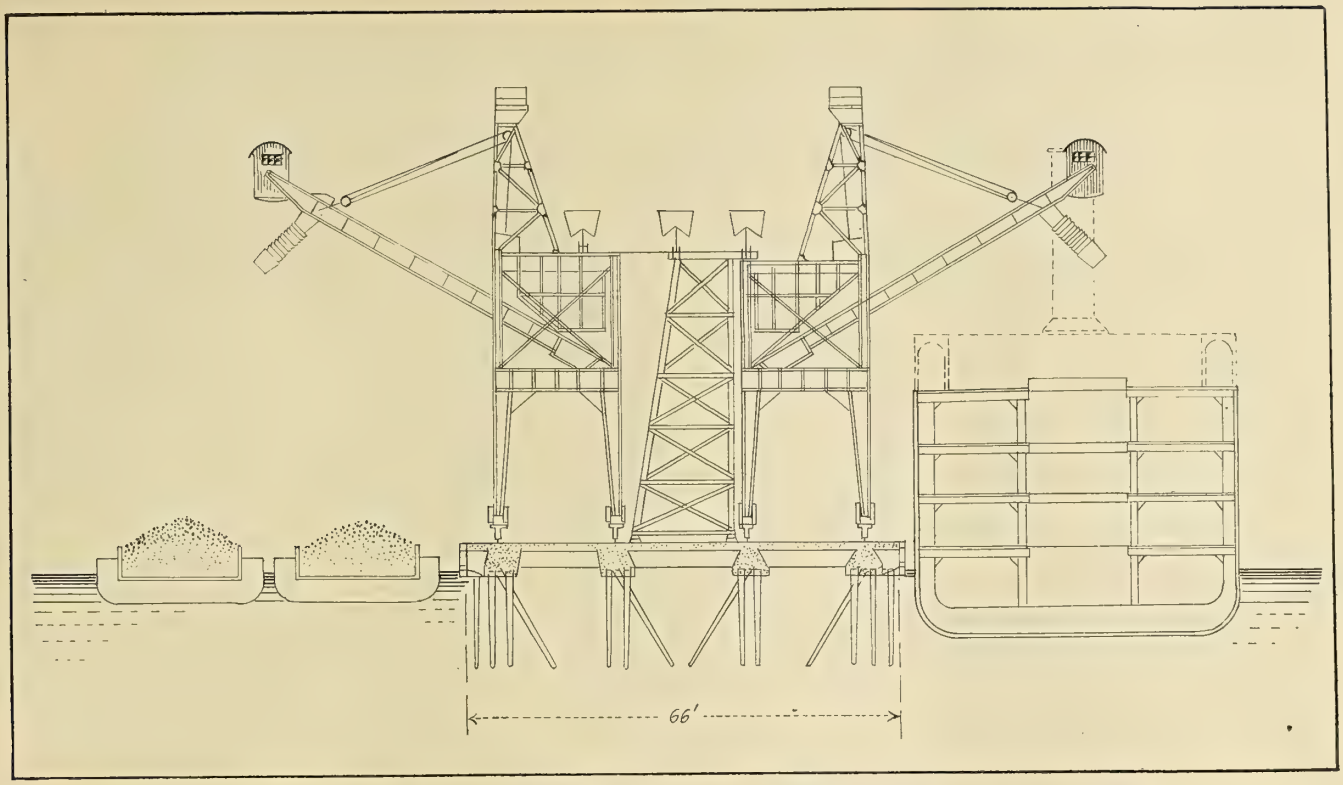


Fig. 3.—Cross Section of Coaling Pier with Capacity of 20,000 Tons Per Day at Canton, Md.

can be built, and built, too, at the least cost comparable with service value. A reinforced concrete dock can be built to withstand any practical impact shock and to carry any desired load. A modern reinforced concrete dock is a real dock—not a dam or a retaining wall. Well designed, it should not develop underscouring currents and eddies. A reinforced concrete dock is rot, rust and fireproof, and offers the maximum service value at a low first and a minimum upkeep cost.

Reinforced Concrete Not Expensive

The idea that a properly designed reinforced concrete pier or wharf structure is unduly expensive is wrong. The writer has in mind a pier that was designed for one of the larger eastern railroads in direct competition with the railroad's own engineers, who designed in timber. The result, according to the figures received from contractors, was astonishing. Not only was the figure submitted for the construction of the reinforced concrete structure lower than the figure for the timber design, but the saving was actually more than eight percent of the total cost of the work. A similar comparison was made recently near the heart of the long leaf yellow pine district. In this case the cost of the reinforced concrete structure was a trifle greater than the cost of a similar structure in timber. The difference was so small and the advantages of the more permanent type were so great that the timber design was not considered.

Life of Timber Piers

The life of timber piles below the perpetual saturation line is indefinite where there are no teredo or other "marine borers." Where marine borers exist an untreated timber pile will last anywhere from six months to five years. Treated piles (creosoted) will last from eight to twenty years. Only a short time ago the writer had occasion to examine some treated piling for one of the Southern railroads that had been driven about eight years ago and found plenty of evidence of teredo navalis.

The palmetto log, found in the South, resists the action of the "borer" to a considerable extent, although the best wood seemingly is the "greenheart" that is found in the northern part of South America. This wood is difficult to obtain and consequently very expensive.

Modern Concrete Structure

The use of the more permanent material in piers and wharves has changed the design to a considerable extent. The ore dock as designed for the Cleveland Furnace Company in 1906 (Fig. 1) has stood up successfully under extreme conditions and in the nine years that it has been in use it has cost nothing for repairs.

The combination ore floor and dock as designed for the Detroit Iron & Steel Company in 1908 is a different type entirely, making for strength as well as permanency. Only recently this dock successfully withstood a tremendous earth movement that completely wrecked adjoining concrete dock structures of a different design.

The progress photograph and cross section of a coaling pier (Figs. 2 and 3) now approaching completion at Canton (Baltimore), Maryland, gives a very clear idea of the methods followed in the design of structures of that class. The pier extends 942 feet into the water of the Patapsco River, which empties into Chesapeake Bay. Railroad coal cars are emptied into a storage bin by the usual form of elevating car dumper at the shore end of the pier; from the bins the coal is carried in small side dump cars that travel up an elevated structure on the pier and empty into movable hoppers which in turn deliver the coal by means of conveyors into the holds of the vessels. The plant has a capacity of 20,000 tons per day. The depth of water is sufficient for vessels drawing 35 feet.

In practically every type of engineering structure reinforced concrete has become the standard building material. Railroad bridges, culverts, dams, irrigation works, heavy building of all kinds—the question is no longer, Shall reinforced concrete be used? It is understood that reinforced concrete is the material and the only material to use. The day has now come when engineers who are responsible for marine structures, especially dock piers, are answering the age-long question in the same way.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Gasket Kink

The gasket of the cylinder head of a high pressure pump was very troublesome, in the matter of blowing out or leaking badly. A good deal of care was given to it each time it was renewed, even cutting the groove in the flange and top of the pump into which the packing was squeezed. This did not cure the trouble, nor would a copper gasket help us any.

An old-time oiler suggested to me that a piece of copper wire of about 3/32-inch thickness, annealed and laid in the groove with lapped ends, would cure us of our troubles. This was tried and found very successful, but anyone that tries the scheme should be very careful to see that the wire lays in the grooves that are cut in the flanges, or that you may cut, and that when setting up the nuts the opposite nuts are taken up on in rotation, this bringing equal strain on the flanges and preventing any chances of cracking.

This joint is ideal where there is call for a quick examination and replacing of any cylinder head, for there is no gasket to stick and require scraping off. It is also very cheap. C. H. W.

Direct and Indirect Valves

Replying to Mr. Kirvan's letter in the September issue, the use of the term "indirect valve" is only governed by good practice, and authorities agree that it has the meaning quoted in the August issue. If it were not for this fact, it would be entirely reasonable to interpret it as you suggest. The term is a poor one to convey the meaning. The following quotations may be of interest:

"The 'valve' having the live steam at the ends and the exhaust in the middle is called the *direct valve*. With the steam in the middle and the exhaust at the ends it is called indirect."—("The Steam Engine," by R. C. H. Heck, p. 186, ed. 1907.)

"The terms *direct* and *indirect* are often used synonymously with *outside* and *inside* admission. A *direct* valve is one having live steam at the two ends and exhaust between. * * * An *indirect* valve is one having exhaust steam at the two ends and live steam between."—("Valve Gears," by B. H. Fessenden, p. 63, ed. 1915.)

Annapolis, Md. Prof. H. A. Everett.

The letter on "Direct and Indirect Valves" on page 425 of the September issue interests me very much. I immediately referred back to the August number to see what had been stated in the answer to the inquiry in question.

I think Mr. Kirvan does not draw a fine enough distinction between the terms *direct and indirect valves* and *direct and indirect connected valves*. The question in the August number refers only to the valves; but it does not at all mention the manner of connection between the valve or valves, and the eccentrics which actuate them. The answer given is clear, to the point, and correct. It answers the question just as it was given, and it neither infers nor assumes anything else.

Mr. Kirvan is correct in his statements concerning the rockers which serve as a connection between the valve stem and the eccentric rod, but that is still true no matter what kind of a valve may be used. So it is quite possible to have direct and indirect valves, and direct and indirect connected valves, or a combination. But in speaking of any valve gear as a whole, it should be particularly specified as to the kind of valve and the kind of rocker, if there be any. This is necessary if one is to make a study of the gear with a view toward analysis.

I think it well to retain the qualifying words "direct" and "indirect" in relation to valves, as no other description that I know of is quite as suitable. Priority is also on the side of the use of these terms for both valves and gear. Charles J. Mason.

Scranton, Pa.

Helpful Suggestions for the Boiler Room

There are many handy kinks that any fellow can learn by a visit to the power plant of another ship and by being a subscriber to good engineering magazines. A few that I have adopted and some of my own origination may be found helpful in other plants.

The breaking of boiler water gage glasses is a frequent occurrence on most ships, due sometimes to vibration of the ship, change of temperature surrounding them (such as starting forced draft), carelessness in blowing them out in cleaning, or in setting up on them when they leak, without first shutting the valves, and a few other causes. We have posted on the bulletin board of each fireroom instructions about these causes and how to try and avoid some of them. This gives all hands a chance to learn, including coal passers, firemen and water tenders, and if engineers would write up some instructions on these subjects and post them for their men to read it will well repay them.

Now when a glass does break, the rapidity or saving of time in getting or putting in a new one is desirable, for even though we have try cocks, the sight of water in the glass is much pleasanter than the use of those. To aid in saving time I have constructed small lockers that are just large enough to hold four spare gage glasses, packing for them, wrenches to fit packing nuts and two packing hooks. One of these lockers is placed in each boiler room. They are painted white and on the door is painted in big letters "Spare gage glasses." The distinct advantage of these lockers is this: the glasses are there at all times for immediate use, and if you are steaming under forced draft and your firerooms are closed, they are handy and there is no time lost in going to the engineers' storeroom, through perhaps a half dozen air lock doors or watertight power doors, to get new ones.

Each of our water columns has a sheet iron guard fitted on one side of it, the side nearest the next glass or water column. This serves the triple purpose of acting as a guard against the water or steam from either glass, when

they break, striking the other glass and breaking it; as a reflector for the light on the water level (being painted white) and as an indicator for the proper height at which to carry the water level, this by painting a red stripe across the guard at the normal waterline. This red stripe is ¾ inch higher on the boilers furthest away from the boiler pumps, on account of the well-known fact that these boilers would be the first to experience trouble in losing water should the feed pumps start working poorly or slow down. All water tenders are instructed that their most important duty is to maintain their water as near that mark as possible, and when trouble is experienced to report it immediately to the engine room or pump room.

Device for Renewing Burned Out Grate Bar

When a grate bar burns out or drops out and you have a hot fire the work of getting a new one in its place in a short space of time can be accomplished if you make a

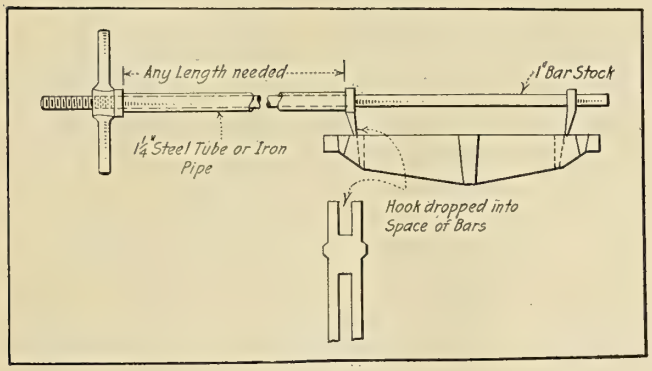


Fig. 1

simple bar clamp as shown in Fig. 1. Without the use of some device such as this the renewing of a bar has to be done with a hoe or slice bar, and we all know that it means the fire door has to be kept open too long, cooling the fires and boiler. This device is well appreciated when you have to put a bar in the back of a furnace. It can be made from lengths of old iron pipe and bar stock, which most ships have stored up somewhere.

Improvised Tube Cleaning Brushes

No doubt some engineers have had the experience of arriving in some port with dirty boiler tubes to be cleaned and found that all their tube brushes were used up. I experienced this, and the necessity was the mother of the following invention, not being able to purchase any in the port at which we were lying:

On all ships we can find plenty of old steel wire cable. Three-eighths inch diameter is the best for small tubes. Take a piece of ¾-inch hexagon stock and drill ⅜-inch holes. Start ½ inch from the end and drill them, one through each flat of the hex, just ⅜ inch from center to center. This, as shown in Fig. 2, gives you a spiral.

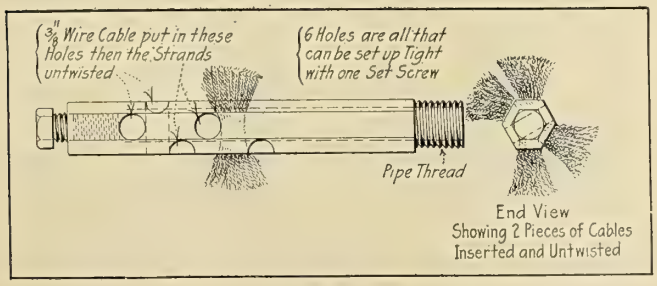


Fig. 2

Drill a hole 7/16 inch through the length and at one end tap it out for a ½-inch or 9/16 inch set screw. The other end turn down and thread for screwing into a ½-inch pipe. Now through the holes of the flats put pieces of cable and set up the set screw at the end, then with a pair of pliers untwist the strands of the cable and you have a fairly good cleaning brush. The lengths of the pieces of cable will depend on the size of the tubes to be cleaned.

C. H. W.

A Practical Discussion of the Effects of Combustion Space Upon Boiler Efficiency

A perusal of boiler history brings out one fact that most practical engineers of to-day seem to have overlooked. This fact is: no radical change in combustion space design. The structural changes, both in material and in placing of parts, have been numerous; nearly every engineer feels himself delinquent until he has in some way changed the baffling, the method of bricking or the arrangement of the internal feed pipes. Undoubtedly these are often of much value and lead to desirable results; but, as stated before, there is a lack of radical changes; the kind of changes that always mark a period of advancement in engineering. And the problem is up to the practical engineer, the man who is in close touch with all the good and bad points of his own special boiler, and he who can make first-hand observations under practical, every day working conditions, as governed by the many and ever-changing circumstances that fall to the lot of the practical engineer. The chemists have solved the problem of combustion and to-day the theory and the requisites of perfect combustion are available to all who put themselves to the trouble of going to the nearest library. The problem of obtaining the necessary requirements for perfect combustion is beyond the scope of chemists; it is the problem that now faces the engineer.

Until of late years the term combustion space held very little significance to engineers, it was simply used to designate a specific section of the boiler, and even to-day there are many to whom it apparently has the same old meaning; a name that is used because every one calls "that space above the grates and surrounded by heating surface," combustion space. But some years ago, when the internal combustion engine began to encroach upon the boiler field, the boiler builders began to sit up and take notice. There was a serious proposition to compete with, and they immediately began to investigate wherein laid the seriousness. It was evidently in the new method of mechanical utilization of the energy developed by combustion. But in addition the internal combustion engine people were going into the process of combustion in great detail and were finding out astonishing facts regarding the combustion of gases and vapors, all more or less similar to the same gases that had to be burned in boilers. So at once the term combustion space began to assume its rightful position in boiler society and was given the recognition long deserved but long neglected. Be this as it may, it is still spasmodic and to-day you can pick up many boiler catalogues, and while you will see references to grate surface, heating surface, baffling, structural integrity, etc., there is no mention of volume of combustion space. This is a fact and in the words of a poet, ignorance is bliss, but it is h—— on coal consumption.

Some few engineers of the day have taken up the matter of combustion space and their work has not only

been of great value, but it has fully paid them for their trouble and time and it is to be regretted that they have not had further opportunities to go on with their work.

The boiler of to-day must be considered as consisting of two fundamental parts: (a) a heat generator; (b) a heat absorber. The first must, for the purposes of analysis, be divided into two parts: (a) a fuel gasifier; (b) a gas burner. So we can consider three operations: (1) gasification of the fuel; (2) burning of the gases; (3) absorption of the heat liberated. Conceding that these three operations are essential to a boiler, it stands to reason that as the efficiency of each operation varies, so will the boiler efficiency vary, as the latter is the product of the former. The operations named above are carried out respectively: (1) on the grate; (2) in the combustion space; (3) by the heating surface. Experiments have demonstrated conclusively that the efficiency of all boilers varies with the rate of combustion, falling off at maximum rates. Furthermore, that this decrease in overall efficiency is due to loss in furnace efficiency, a straight line law being applicable to heat absorption. Hence the logical conclusion is that there is something wrong with the heat generating ability of the boiler; and as the average boiler of to-day receives the greater amount of its heat by convection, and with the same boiler grate conditions being similar, it is quite apparent that the fault can be traced to the combustion space conditions. A brief consideration of conditions will lead to the same conclusion.

The combustion of coal in a furnace is a chemical process in which oxygen reacts with the carbon and the various combinations of carbon and hydrogen. Consider the grate covered with a layer of fuel; heating takes place and the volatile of the fuel begins to distill and rise into the combustion space. If the rate of heating is slow the total combustible matter driven off as volatile is small and gaseous in composition; if the rate of heating is rapid the amount of volatile is large and contains much tar vapor. The former burns rapidly, the latter burns slowly. In short, with any given grate surface, there can be generated varying amounts of volatile, this volatile varying in combustion and requiring more or less time to burn, as the case may be. Therefore it is quite safe to say that if the combustion space is of proper volume for the one case it is most certainly not correct for the other case. Or to put it generally, combustion space must be the result of something and not something that results. Combustion space must bear a definite relation to the rate of combustion, otherwise maximum efficiency cannot be attained.

Type.	G.S. Sq. Ft.	Combustion Space Ft.³	Combustion Space With Fire 1′ Thick.	Ratio Column 2 and 3.	Ratio Column 2 and 4.	Rate of Combustion Lbs. Coal per Sq. Ft. G. S.	Seconds each Cubic Foot Stays in Combustion Space.
Normand (*a*)..	58.6	136	78	2.34	1.33	40	.077
Locomotive (*a*)	30	160	130	5.34	4.33	60	.17
Heine (*a*).....	35	250	215	7.14	6.14	25	.58
B & W (*b*)....	87.4	318	230.6	3.64	2.64	42	.15
B & W (*b*)....	87.4	318	230.6	3.64	2.64	13	.49

(*a*) Bureau of Mines Bulletin No. 23.
(*b*) Writer's Notes.

A consideration of the above shows that there is a wide variation in the ratio of combustion space to grate surface; also that the time allowed for the combustion of the volatile in the combustion space is small. Any chemical action that takes place in this time must be in the nature of an explosion. It will also be noticed that as the thickness of the fire bed increases, the combustion space decreases; likewise the period allowed for combustion, so that at high rates of combustion, great volumes of black smoke may not always be caused by improper firing, but caused by something beyond the fireman's control.

To consider a special case, take the B. & W. boiler, listed in the table above. The table shows that at the maximum rate of combustion, the time allowed for combustion of the volatile in the combustion space is about .2 of a second, increasing to .5 of a second at ordinary rates. Furthermore, as the rate of combustion increases the volume of combustion space decreases, due to the thickness of the fire bed, a necessary evil. In this case, a bed one foot thick reduces the original combustion space by eighty-seven cubic feet or 27 percent. And with the increasing amount of volatile, such volatile being of the kind that burns slowly, not a decrease of combustion space is desired, but most positively an increase.

What the proper volume of combustion space for given conditions of fuel consumption is can only be determined for each type of boiler by experiment. For boilers that steam year in and year out at a fixed capacity, the solution of this problem will be of the greatest benefit; for other boilers, namely, those that steam at various capacities, an investigation will, in all probability, be of benefit, for it is firmly believed, in view of the above facts, that in the average boiler of to-day the combustion space is too small.

In case that anyone desires to figure out the above data for his own boilers, the following procedure was carried out as regards the B. & W. boiler:

A sectional view blue print was used. The combustion space was divided into triangles, taking care to use right triangles when possible, as the area of these triangles can be obtained with length of base and altitude known —area being equal to one-half the base times the altitude. In the other triangles the following rule was used for obtaining the area: from half the sum of the three sides subtract each side severally; multiply together the half sum and the three remainders, and extract the square root of the product. Having obtained the sectional area, by adding the areas of the triangles, multiply by the width of the furnace and the result is the cubical space. To obtain column four, subtract as many cubic feet as there are square feet of grate surface. Column seven can be obtained from data on hand.

To obtain column eight, proceed as follows: Each pound of fuel will generate about twenty pounds of gases and water vapor. The temperature of these gases can be assumed to be about twenty-five hundred degrees Fahrenheit; so we get the following: Pounds of coal per square foot of grate surface multiplied by twenty, divided by thirty-six hundred, equals pounds of gases liberated per second. This under standard conditions. To reduce to conditions of the furnace temperature: Pounds of gases liberated per second multiplied by twenty-nine hundred and sixty multiplied by twelve and thirty-eight hundredths divided by four hundred and sixty equals cubic feet of gas liberated per second in the combustion space. Now divide column four by this last and the result will be the answer in seconds. D.

Launch of the S.S. Paris.—The new French Liner *Paris*, of the Compagnie Generale Transatlantique, was launched at St. Nazaire, France, on September 12. The vessel is 760 feet long, 85 feet beam and 59 feet depth from main deck to keel. Her displacement will be about 37,000 tons and she will be driven by quadruple screws actuated by steam turbines.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

Analysis of Stresses

Q.—(1) In the portion of bracket marked *A* (Fig. 1) would there not be a bending moment in addition to the tensile stress? How would the stresses be analyzed in this case, to show the amount of greatest stress and also location?

(2) In the rectangular nozzle or pipe (Fig. 2), with 30 pounds pressure inside of pipe, the tensile stress on the stays would be found, I presume, by

$$\frac{24 \times 24 \times 30}{\text{area of stay}}$$

but the difficult part is in finding the stress on ½-inch steel plate 24 by

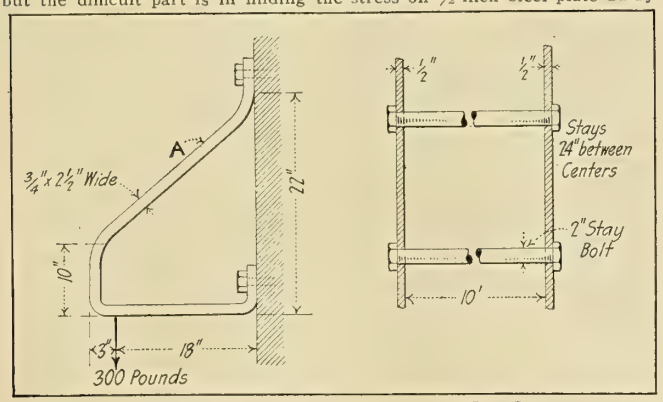


Fig. 1

Fig. 2

24 inches uniformly loaded with 30 pounds per square inch, supported at the four corners. How would this stress be figured?

(3) What books will aid me in solving these problems? DRAFTSMAN.

A.—The problems do not admit of exact solutions, but may be approximated. In the bracket problem, first consider the entire frame as consisting of the straight bar *CD* and the curved bar *AC* (Fig. 3). The reactions at *A* and *D* are as indicated, their *H* and *V* components being indicated separately. Taking moments about *A* we have

$$D_h\ (22) = 300\ (18)$$

$$D_h = \frac{300\ (18)}{22} = 245 \text{ pounds.}$$

Since the sum of the horizontal forces $= O$, $(\Sigma H = O)$ we have $A_h = D_h = 245$ pounds.

Isolating the part *CD* and replacing the forces acting on it by *H* and *V* components, we have the following figures:

Consider *CD* as a beam supported at the ends.

From $\Sigma H = O$ we have $C_h = D_h = 245$ pounds.

Taking moments about *C*, we have

$$21\ D_v = 300\ (3)$$

$$D_v = \frac{300}{7} = 42.8 \text{ pounds.}$$

$$C_v = 300 - D_v = 257.2 \text{ pounds} = A_v.$$

Now the direct stress in $CD = C_h = D_h = 245$ pounds compresion, and the maximum moment is over the load of 300 pounds and is $Dv\ (18) = 770$ inch pounds. The maximum compression due to bending

$$= \frac{My}{I} = \frac{770\ (3/8)}{.088} = 3{,}280 \text{ pounds per square inch.}$$

$$\text{Maximum total compression} = 3{,}280 + \frac{245}{1.875} = 3{,}410$$

Now consider the curved beam *A B C* (Fig. 5) with forces acting on it. In the portion *A B* the bending moment at any point $P = M = A_h y - A_v x$, but from similarity of triangles.

$$\frac{y}{x} = \frac{12}{21}, \text{ or } y = \frac{12x}{21} = \frac{4x}{7}.$$

Hence $M = x\left(\frac{4}{7}A_h - A_v\right)$

This increases with x and is a maximum at *B*, where $x = 21$. Its value at this point is

$$M = 21\left(\frac{4}{7}(245) - 257.2\right) = 2460\text{-inch pounds.}$$

The direct stress in *AB* is equal to the sum of the components of A_v and A_h in the direction of *AB*. This is found as follows:

Component of A_h in line of *AB*

$= A_h \cos \alpha$

$$= A_h\left(\frac{21}{\sqrt{585}}\right)$$

Component of A_v in line of $AB = A_v \cos \beta$.

$$= A_v\left(\frac{12}{\sqrt{585}}\right)$$

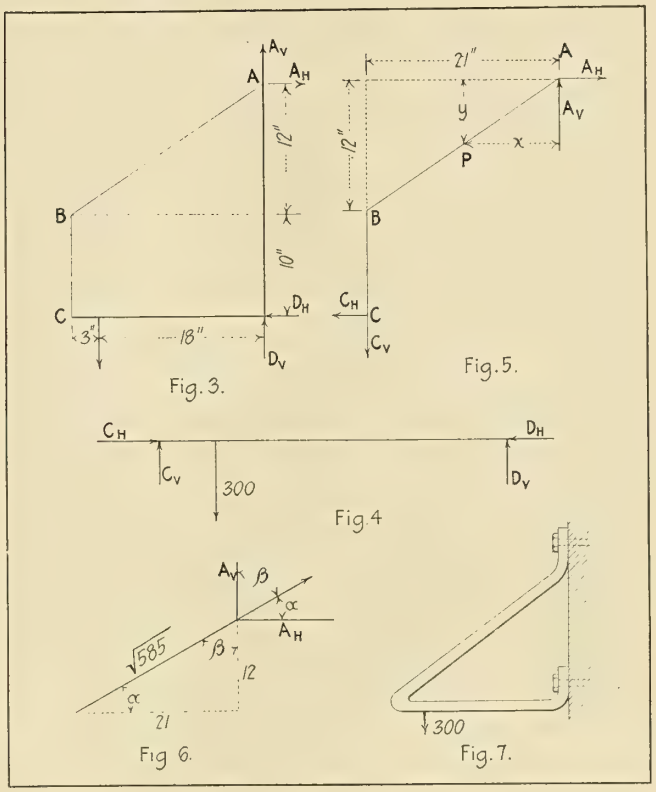


Fig. 3. Fig. 5. Fig. 4 Fig. 6. Fig. 7.

$$\text{Direct stress} = \text{sum} = \frac{1}{\sqrt{585}}(21A_h + 12A_v).$$

$$= \frac{1}{\sqrt{585}}[21\ (245) + 12\ (257.2)] = 341 \text{ pounds.}$$

Tension due to moment

$$= \frac{My}{I} = \frac{2460\ (3/8)}{.088} = 10{,}470 \text{ pounds per square inch.}$$

$$\text{Direct stress} = \frac{341}{1.875} = 182 \text{ pounds per square inch.}$$

Total maximum stress $= 10{,}470 + 182 = 10{,}652$ pounds per square inch.

The portion *BC* is under a direct stress $= Cv = 257.2$, and the maximum moment is at *B* and has the same value

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

as found above. Hence the value found above (10,652 pounds per square inch) governs the design.

(2.) The equation for finding the stress in a flat plate supported at points in equidistant rectangular rows is givin in Peabody and Miller's "Boiler Design" as

$$f = \frac{2a^2}{9t^2} P,$$

in which a is the distance of points in a row, t is the thickness of the plate, P is the pressure in pounds per square inch, and f is the stress in pounds per square inch.

In this case

$$f = \frac{2\,(24)^2}{9\,(1/2)^2}\,(30)$$

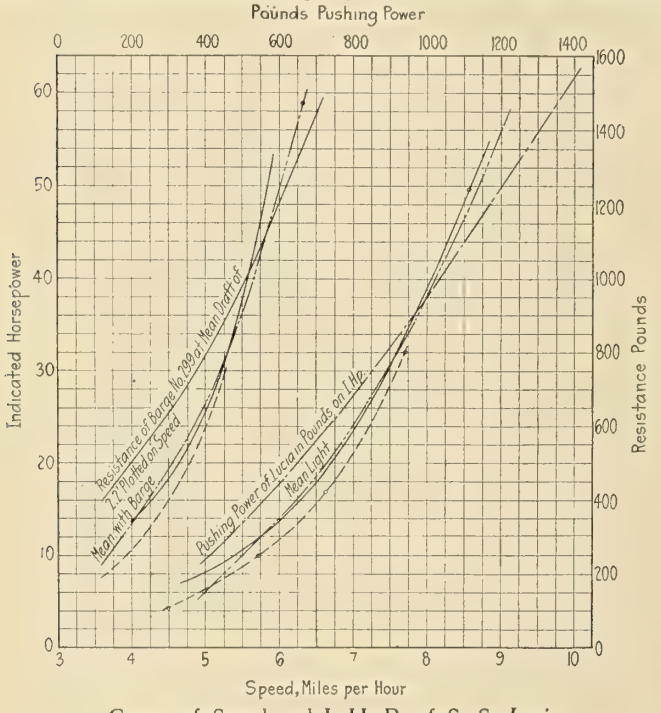
$$= \frac{34{,}560}{(9/4)} = \frac{4(34{,}560)}{9} = 15{,}460 \text{ pounds per square inch.}$$

(3.) Good books on stresses are Fuller and Johnston's "Applied Mechanics," volume 1, pages 1-66 inclusive; Hancock and Slocum's "Strength of Materials."

The bracket of problem (1) is a poor design, as the introduction of the curve in AC produces a large bending stress which would practically be eliminated by making AC straight. The form shown in Fig. 7 would be much better, and the bending stress in it could be neglected without material loss of accuracy.

Efficiency of Radial and Feathering Wheels

Q.—Our paddle-wheel steamer *Lucia* is a small river boat 60 feet by 16 feet by 20 inches draft. During the winter her wheel was changed from a radial wheel 9 feet diameter, 9 feet long, with 12 buckets 16 inches wide, 18 inches immersion, to a feathering wheel 8 feet 6 inches diameter, with 9 buckets 16 inches wide, and later to buckets 20 inches wide. As shown on enclosed diagram, the radial wheel within the limits of its speed proves to have the best efficiency. I do not know the eccentricity of the feathering wheel, but its mechanical operation is very good. From the report of the United States Towboat Board, from experiments by Prof. Sadler, of the University of Michigan, it is shown that a feathering wheel in nearly all cases is more efficient than a radial wheel. What is your opinion for the higher efficiency of this radial wheel?



Curves of Speed and I. H. P. of S. S. *Lucia*

Dotted curve, radial wheel; solid curve, feathering wheel, immersion 16 inches; dot and dash curve, feathering wheel, immersion 18 inches.

In your reply to a question in the July (1916) issue of MARINE ENGINEERING, pages 346-347, you make the statement that the constant C in the formula for wetted surface ($W.\ S. = C\sqrt{D} \times L$) should be 16 to 16.5. I take the liberty to state that I have worked out several calculations for wetted surface for our shallow-draft river boats, and find that C varies from 18.5—22, depending on the block coefficient. For a block coefficient of 78 C proves to be 20.7. The range of C from 18.5 to 22 covers block coefficients from 72 to 85 without much error. M.

A.—Efficiency is not always the best criterion on which to judge performance, as sometimes sufficiency is of more importance, if a certain amount of work has to be performed. The best published information as to paddle wheel action is contained in the report you mention, but it is essential that in selecting a wheel to do a certain work that it should be of such size that it can perform that work under conditions which are reasonable for its effective action. For example, *slip* is one of the prime variables in estimating both efficiency and power delivered by a propeller or paddle wheel, and it is perfectly possible to have a wheel of improper dimensions, say too large or too small, working at a slip widely removed from that for best efficiency but still performing the same resultant work that a wheel of better dimensions and working at a better slip would perform. The analysis of performance of a given wheel under different conditions, such as varying speeds or loads (which means at varying slip) can best be followed by noting the effect on *both* the curves of efficiency and thrust, and no complete conception of performance can be obtained without noting *both*.

Suppose in the light condition and running free, the slip is 20 percent, the effective thrust could be read from the curves of Fig. 1 made for this wheel. This is for a certain revolutions per minute, speed and indicated horsepower; now suppose the revolutions per minute are increased considerably, the speed would not increase quite so much, consequently the slip would increase and both the thrust and efficiency would change, one increasing, the other decreasing, and the indicated horsepower would increase. This same would be obtained by increasing the resistance by attaching a tow, the revolutions per minute being held the same.

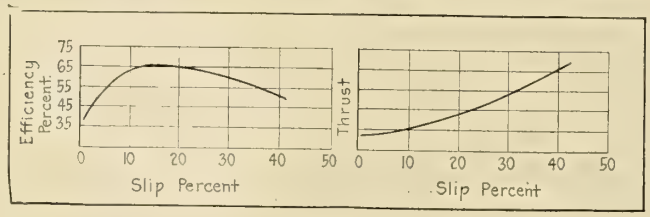


Fig. 1

Having seen the effect of varying the operating conditions of a given wheel, it is obvious that for any given service there is an infinite number of combinations of dimensions which will produce the result, but it is only those which give a unit that operates at the desired *slip* that will be most efficient. To refer again to Fig. 1, many of the towboats are designed to operate when loaded at a very high slip (60 to 70 percent), and the operation light is at a much less slip, higher speed and better efficiency. Apparently the feathering wheel has dimensions unsuited to the work it is called on to perform.

You have not imposed the condition of sufficiency into a comparison of efficiency, as the feathering wheel cannot do the work cut out for the radial. The revolutions per minute of each wheel are not given, and in absence of this information a definite statement cannot be made, but if the revolutions of the radial were lower than those of the feathering for the same speed, it would seem that a larger feathering wheel should be used, and conversely. In any case it is well to bear in mind the limitations of the original data, and it is very doubtful if the accuracy of this is such that conclusions from differences of 5 percent on power or less are tenable. Moreover, the speed determination is always a difficult one to obtain accurately, and it is interesting to note that an error in determining this, of from ⅛ to ¼ of a mile per hour, would entirely wipe out the difference in the two curves.

The information as to the values of the coefficient in Taylor's formula for wetted surface when applied to shallow draft vessels is very welcome and we are indebted to you for your kindness.

Shipbuilding and General Marine News

Contracts for New Ships—Marine Terminal Improvements—Recent Launchings—Improved Appliances—Personal Items

Steel merchant vessels building, or under contract to be built, in private American shipyards on September 1, according to builders' returns to the Bureau of Navigation, Department of Commerce, number 397 of 1,292,310 gross tons. It is expected that 332 of these vessels, aggregating 968,461 gross tons, will be launched during the current fiscal year, although the launching dates will, of course, be subject to the usual allowances for delays.

During August new contracts for 20 vessels of 75,060 gross tons were placed with American shipbuilders, and 12 vessels of 35,166 gross tons were completed. In the seven months from February 1 to September 1, American shipyards entered into contracts to build 229 steel vessels of 576,857 gross tons, and in this period completed 55 steel vessels of 206,545 gross tons.

Bids for a large portion of the first year's construction of the new naval building programme will be opened within a few weeks. Of the vessels authorized in this act, 66 of about 382,000 tons displacement must be begun as soon as practicable. As neither the New York nor Mare Island Navy Yards can undertake additional constructional work, and as a fuel ship will be built at the Boston Navy Yard, a hospital ship at the League Island Navy Yard, Philadelphia, and a gunboat at the Charleston, S. C., Navy Yard, practically all of the remaining vessels must be built in private yards.

It is significant that all deliveries of steel plates and shapes for shipbuilding recently contracted for will not be made until the third quarter of 1917, while practically all of the plate mill capacity for shipment during the first half of next year has been previously taken up aside from the options given on tonnage for this year's delivery and that held in reserve for Government work. The Carnegie Steel Company has already sent notices to customers who have placed orders for material for 1917, that in the event of the Government calling on the company for material for the naval construction programme, this demand will be given precedence to a reasonable extent in order to enable the Government to carry out its preparedness programme for the navy without unreasonable delay. Between the demands for steel and skilled labor that will be required for this extensive building programme, it is evident that new shipbuilding enterprises will have difficulty in competing for orders for anything like immediate delivery.

Shipbuilding Contracts

The naval bill just passed by Congress provides that work is to be begun during 1917 on four battleships, four battle cruisers, four scout cruisers, twenty destroyers, twenty submarines, one fuel ship, one ammunition ship and one hospital ship.

Wm. Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., has received an order to build two more steamers for W. R. Grace & Company, New York.

The Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md., has secured an order to build two more ships for Norwegian delivery.

The Willamette Iron & Steel Works and the Northwest Steel Company, Portland, Ore., will build three more ships for Lauritz Kolster, Stavenger, Norway. This makes a total of eight vessels recently contracted for by these two companies.

The Seattle Construction & Dry Dock Company, Seattle, Wash., has a contract with Norwegian interests for three 7,500-ton steel freight steamers to cost $2,650,000.

J. F. Duthie & Company, Seattle, Wash., have received a contract to build three 8,800-ton steel freight ships for Hannevig & Johnsen, New York.

The Alaska Steamship Company, Seattle, Wash., is planning the construction of three passenger boats to ply between Seattle and Alaska.

Kruse & Banks, Marshfield, Ore., have a contract from the C. A. Smith Lumber Company, Oakland, Cal., for the construction of a wooden vessel 260 feet long, to be equipped with steam turbines.

The Mathews Shipbuilding Company, Hoquiam, Wash., has received a contract from W. R. Grace & Company, New York, to build two wooden lumber-carrying vessels, to be equipped with internal combustion engines.

The Columbia Engineering Works, Portland, Ore., will build three auxiliary schooners for M. T. Snyder, New Orleans, La.

The Texas Company, Bath, Me., has $3,500,000 worth of work now under way, including four large steamships, two harbor steamers and one tug.

The Isthmian Canal Commission, Washington, D. C., will soon ask for bids for the construction of two 12,000-ton colliers to cost $1,500,000 each.

It is reported that Barbare Bros., Tacoma, Wash., will build several auxiliary schooners for A. O. Anderson & Company of Norway.

The United States Government has authorized the construction of a gunboat, 241 feet 2 inches long, 41 feet 2½ feet beam and 11 feet 4 inches draft, of about 1,575 tons displacement, to cost $600,000, at the Navy Yard at Charleston, S. C. Hitherto no craft larger than a tug has been built at the Charleston Navy Yard.

The Coastwise Shipbuilding Company, Baltimore, Md., has a contract from a Chilean firm for a vessel for the copper and coal trade along the west coast, to be equipped with semi-Diesel engines.

Bids were opened on September 5 by the Navy Department for 30 hydro-aeroplanes to be used by the Aviation School at Pensacola, Fla.

It is reported that plans are under way for the construction of four steel freighters of 5,000 tons each at the Grand Trunk Pacific Dry Dock Plant of Prince Rupert, British Columbia.

Fuel ship *No.* 12, U. S. S., will be built at the Navy Yard, Charlestown, Mass., at a cost of $1,500,000. The vessel will be 475 feet ong over all, 56 feet beam and 33 feet depth, with a displacement of 14,500 tons.

The Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md., has received a contract from Gustav Bull, Norway, for two cargo steamers, each of about 6,200 tons deadweight carrying capacity, to be built on the Isherwood system of framing and to be propelled by geared turbines.

It is reported that the Union Iron Works, San Francisco, Cal., are building two large cargo steamers on speculation, at their Alameda plant.

The Standard Shipbuilding Company, Shooters Island, N. Y. (New York City office, 44 Whitehall street), has received contracts to build three steel freight steamships, each to be 392 feet long.

J. F. Duthie & Company, Seattle, Wash., has received contracts from Norwegian interests to build three large steel freight steamships.

The Pennsylvania Shipbuilding Company, whose main office is Land Title building, Philadelphia, is reported to have received orders to build five ships and to have placed a contract for the necessary steel.

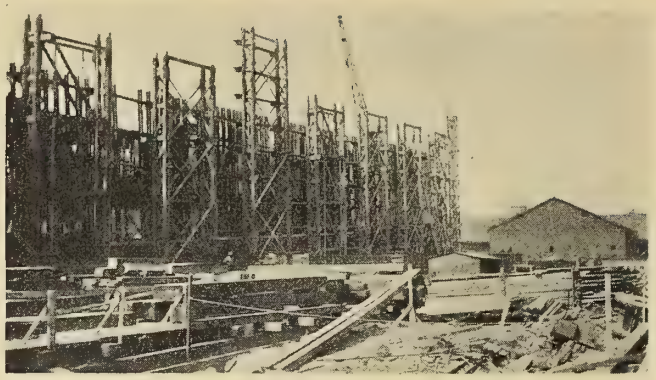
The Sun Shipbuilding Company, 1428 South Penn Square, Philadelphia, Pa., is reported to be about to begin work on four oil tank ships at its yard in Chester, Pa.

The Coastwise Shipbuilding Company, Baltimore, Md., will build several barges for the Reading Railroad Company, Philadelphia, Pa.

The Standifer-Clarkson Company, North Portland, Ore., will build a four-masted wooden schooner for Libby, McNeill & Libby.



Building Ships at Chester Shipbuilding Company's Yard



Tank Steamer in Frame at Chester Shipbuilding Plant

Shipyard News

The Standifer-Clarkson Company, Astoria, Ore., succeeds the McEachern-Standifer-Clarkson Ship Company. G. M. Standifer, Jesse Stearns and J. M. Robinson, all of Astoria, are the incorporators.

The Georgia Shipbuilding Company has been incorporated at Savannah, Ga., and will build a shipyard on Hutchinson Island. It is reported that the company already has on hand contracts for three wooden schooners and that it intends later to build steel steamers.

Hillyer, Spearing & Dunn, Jacksonville, Fla., are planning to establish a shipyard at Jacksonville. They report that they already have contracts to build four four-masted schooners, 200 feet long each. These vessels have been designed by Cox & Stevens, naval architects, New York.

The Peninsular Shipbuilding Company has been organized to establish a shipyard at Portland, Ore., for the construction of wooden vessels.

The Seattle Construction & Dry Dock Company, Seattle, Wash., which is now employing 1,750 men, will soon increase this number to 2,000.

Announcement was recently made of the intention to establish a fourth shipyard for building wooden vessels near Portland, Ore. William H. Curtis, naval architect, of Portland, will be manager.

The Tebo Yacht Basin, South Brooklyn, N. Y., has recently been acquired by the Todd Shipyards Corporation, New York, of which William H. Todd is president. In addition to this plant the Todd Shipyards Corporation now controls the Robins Dry Dock & Repair Company, Erie Basin, Brooklyn, N. Y.; Tietjen & Lang Dry Dock Company, Hoboken, N. J., and the Seattle Construction & Dry Dock Company, Seattle, Wash. The Tebo Yacht Basin will continue under the management of Theodore D. Wells, naval architect and marine engineer, of 32 Broadway, New York.

The R. L. Bean Shipyard, at Camden, Me., where the first of the world's six-masted schooners was built, now has contracts for three years' work.

The new shipbuilding plant of J. F. Duthie & Company, Seattle, Wash., will be laid out on a site covering 12 acres. Four building slips will be erected and equipped with an aerial cable system for handling material. Contracts have been placed for a 100-foot by 180-foot machine shop, a 208-foot by 80-foot mold loft, a pipe fitting shop, blacksmith's shop, carpenter and joiner shops and general store and office building. A floating dry dock of about 5,000 tons capacity, designed by William T. Donnelly, consulting engineer, New York, will be provided for handling repair work.

A 20,000-ton floating drydock with steel wings and wooden pontoons has been designed by William T. Donnelly, consulting engineer, New York, for the Sparrows Point shipyard of the Bethlehem Steel Company.

The shipbuilding plant of the Ellicott Machine Corporation, Baltimore, Md., has been leased to the Riter-Conley Manufacturing Company, Pittsburgh, Pa., a subsidiary of the McClintic-Marshall Construction Company. The plant has been leased for the purpose of building barges for carrying oil and general cargo, contracts for which have already been secured.

Norwegian Oil Steamer Malmanger Launched at Chester Yard

The launching of the Norwegian oil tank steamer *Malmanger,* on August 26, at the yards of the Chester Shipbuilding Company, Chester, Pa., is an event that should prove of considerable interest in marine and shipping circles, as typifying a revival of American shipbuilding activity.

Previous to the launching of the *Malmanger* there has been no activity in shipbuilding at this yard, which was at one time the John B. Roach yard, since the building of the *City of Savannah* for the Ocean Steamship Company in 1907.

Besides the *Malmanger* thirteen other ships are now under construction at the yards of the Chester Shipbuilding Company. All are to be equipped with propelling machinery, consisting of Westinghouse cross-compound turbines with double reduction gears and condensing equipment. The *Malmanger* is one of the newest type of oil tank steamers, and will have a capacity of 8,800 tons of oil in bulk. She is 401 feet long, 54 feet beam, 32 feet deep, with a draft of 26 feet, and will have a speed of ten and one-half knots .

Recent Launchings

The motor houseboat *Vagabondia,* designed by Cox & Stevens, naval architects, New York, for Mr. W. L. Mellon, Pittsburgh, Pa., was launched at the yards of the Gas Engine & Power Company and Chas. L. Seabury & Company, Morris Heights, New York, on September 14. The vessel is of wood, 130 feet long, 23 feet 6 inches beam and 3 feet draft, propelled by two 200-horsepower Winton engines, driving propellers arranged in tunnels. On account of its shallow draft the hull is strengthened by steel girders.

The oil tank motor ship *Ralph M. Bullowa,* one of four ships originally designed by Cox & Stevens, naval architects, New York, for the Transatlantic Motor Ship Company, Christiania, Norway, but recently sold to the Vacuum Oil Company, New York, was launched from the yards of the Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md., on September 17. The vessel is built with Isherwood framing, and is 300 feet long over all, 47 feet beam and 28 feet molded depth. The oil tanks, thirteen in all, have a total capacity of 5,000 tons. The designed speed of the vessel at a load draft of 22 feet 8 inches is 10 knots.



S. S. *Malmanger* After Launching at Chester Shipyard



Motor Boat Fleet Passing Between Battleships *Maine* and *New Jersey* on Civilian Naval Practice Cruise.

The power boat *Privateer,* built by the Gas Engine & Power Company and Chas. L. Seabury & Company, Con., Morris Heights, New York, for Dock Commissioner R. A. C. Smith, of New York, was launched early in September. The vessel is 72 feet long, 11 feet 3 inches beam and 3 feet 3 inches draft, designed for a speed of 25 miles an hour.

The United States submarine *L-6* was launched on August 31 from the yards of the California Shipbuilding Company, Long Beach, Cal.

The oil tanker *Astral,* under construction for the Standard Oil Company of New York, was launched at the Union Iron Works, San Francisco, on August 29. The vessel is 457 feet long over all, 58 feet beam and 41 feet depth, with a capacity of 80,000 barrels of oil. Her speed is 11 knots, and she will be used in the Transpacific service to China.

The steam trawler *Whitecap,* the third of a fleet of five boats for the Bay State Fishing Company, Boston, Mass., was launched on August 28 by the Manitowoc Shipbuliding Company, Manitowoc, Wis.

The oil tank steamer *Sunoil* was launched by the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., on August 31, for the Sun Oil Company, Philadelphia. The vessel is of 11 knots speed and 10,000 tons deadweight carrying capacity, and will be used in the transatlantic trade.

The first of two steamships building by the Seattle Construction & Dry Dock Company, Seattle, Wash., for the New York & Cuba Mail Company (Ward Line), New York, was launched on September 20. A sister ship will be launched early in October.

The steamship *Paris,* of the Compagnie Générale Transatlantique, was launched at Saint Nazaire on September 12. The vessel is 639 feet long, 84 feet beam, of about 37,000 tons displacement. She will have accommodations for about 3,000 passengers.

The steamship *Edward Luckenbach,* the first of five steamers under construction by the Fore River Shipbuilding Corporation, Quincy, Mass., for the Luckenbach Line, New York, was launched on September 14. The vessel is 456 feet long over all, 57 feet beam, with a depth of 41 feet. Propulsion will be by a 4,000-shaft-horsepower Curtis turbine, driving a single propeller through reduction gears.

The four-masted schooner *Ada Tower,* of 528 registered tons, was launched from the Cochrane shipyard, Port Greville, N. S., on September 1.



Flagship *Sunbeam II* of Motor Boat Fleet on Civilian Naval Cruise

Pennsylvania Shipbuilding Company Lays Keel of Its First Vessel

The Pennsylvania Shipbuilding Company laid the keel of its first 7,000-ton oil tanker at its Gloucester, N. J., plant on Saturday, September 9, in the presence of the officers of the company, city officials, government marine inspectors and officials of other shipbuilding companies.

Although the work of constructing the new shipyard was started only six months ago and several of its buildings are still incomplete, work will be rushed on the first ship and, in the near future, keels of other ships intended for the merchant marine will be laid.

The company is building six 7,000-ton oil tankers and four 12,500 cargo boats. All will be equipped with steam turbines and reduction gears for a sea speed of 11 knots.

The main office of the company is in the Land Title Building, Philadelphia. The officers of the company are: H. E. Norbom, president; Charles H. Moyer, vice-president; Henry Lysholm, general manager, and George S. Hoell, secretary and treasurer.

Concrete Vessels, Designed by Norwegian Engineer, to be Build in America

The concrete lighter, which, according to the daily press, recently arrived at Christiana, was built by a company organized in Norway by Mr. Max Holzapfel, in order to exploit the patents of Mr. Fougner, a young Norwegian engineer.

We are informed that in all six lighters have been built at the shipbuilding yard in Moss, Norway, which has been acquired by the company, and that a contract has also been made for building floating docks on Mr. Fougner's patented method.

We are informed that Mr. Fougner is coming to New York the early part of next year, when he proposes to form a similar company for exploiting his patents in America in conjunction with his brother in New York and Mr. A. C. Holzapfel.



Elwell-Parker Electric Storage Battery Trucks



Elwell-Parker Tractor and Trailers at Steamship Pier

New Members and Managers of the American Bureau of Shipping Elected

At a meeting of the American Bureau of Shipping, held on August 22, the following additional members were elected to the Bureau:

UNITED STATES GOVERNMENT REPRESENTATIVES

Admiral D. W. Taylor, U. S. N., Naval Constructor, Chief of Bureau of Construction and Repair, Navy Department, Washington, D. C.

Rear-Admiral Robert S. Griffin, U. S. N., Engineer in Chief, Chief of Bureau of Steam Engineering, Navy Department, Washington, D C. E. C. Gillette, U. S. N., Naval Constructor, Navy Department, Washington, D. C. Geo. Uhler, U. S. Supervising Inspector-General, Steamboat Inspection Service, Washington, D. C. C. A. McAllister, Engineer in Chief, U. S. Coast Guard, Washington, D. C.

REPRESENTATIVES OF COMMERCIAL FIRMS

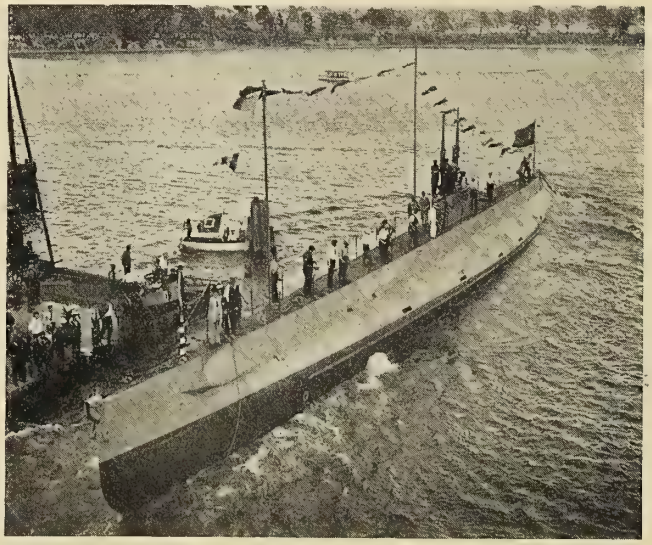
M. Bouvier, vice-president, W. R. Grace & Company, New York. J. G. Crowley, treasurer and general manager, Coastwise Transportation Company, Boston, Mass. W. J. Davidson, president, Staten Island Shipbuilding Company, New York. Geo. B. Drake, naval architect, Texas Company, New York. O. D. Duncan, Duncan & Mount, Proctors in Admiralty, New York. J. H. Gardner, vice-president, New England Steamship Company, New York. J. R. Gordon, traffic manager, Union Sulphur Company, New York. Harvey D. Goulder, Goulder, White & Garry, Proctors in Admiralty, Cleveland, Ohio. Robert M. Grant, president, New England Coal & Coke Company, Boston, Mass. Charles S. Haight, Haight, Sandford & Smith, Proctors in Admiralty, New York. H. W. Hand, vice-president, Wm. Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa. J. H. Jenkins, president, Merchants & Miners Transportation Company, Baltimore, Md. C. W. Jungen, manager, Southern Pacific Company, New York. E. F. Luckenbach, president, Luckenbach Steamship Company, New York. J. Lewis Luckenbach, vice-president, Luckenbach Steamship Company, New York. H. A. Magoun, vice-president, New York Shipbuilding Company, Camden, N. J. S. D. McComb, president, S. D. McComb & Company, Inc., New York. Wm. H. McGee, president, Wm. H. McGee & Company, New York. J. A. McGregor, president, Union Iron Works, San Francisco, Cal. F. D. Mooney, president, New York & Porto Rico Steamship Company, New York. Edgerton Parsons, Parsons & Company, New York. J. Howard Pew, president, Sun Shipbuilding Company, Philadelphia, Pa. W. H. Pleasants, president, Ocean Steamship Company of Savannah, New York. T. F. Rowland, Jr., president, Continental Iron Works, Brooklyn, N. Y. James Shewan, president, James Shewan & Sons, Brooklyn, N. Y. H. S. Snyder, vice-president, Bethlehem Steel Corporation, South Bethlehem, Pa. H. N. Townsend, director, Willcox Peck & Hughes, New York. H. B. Walker, president, Old Dominion Steamship Company, New York.

Additional managers of the Bureau were also elected, consisting of the following:

John S. Ashley, chairman, Great Lakes Protective Association, Cleveland, Ohio. W. G. Coxe, president, Harlan & Hollingsworth Corporation, Wilmington, Del. W. A. Dobson, naval architect, Wm. Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa. H. L. Ferguson, president, Newport News Shipbuilding & Dry Dock Company, Newport News, Va. H. S. Grove, president, Wm. Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa. Charles L. Hutchinson, Hutchinson & Company, Cleveland, Ohio. S. M. Knox, president, New York Shipbuilding Company, Camden, N. J. Wm. Livingstone, president, Lake Carriers' Association, Detroit, Mich. E. P. Morse, president, Morse Dry Dock & Repair Company, Brooklyn, N. Y. F. C. Munson, president, Munson Steamship Company, New York. J. W. Powell, president, Fore River Shipbuilding Corporation, Quincy, Mass. W. A. Prime, director, Willcox Peck & Hughes, New York. Chas. Skentelberry, marine superintendent, New England Coal & Coke Company, Boston, Mass. Wm. A. Thompson, Jr., vice-president, Texas Company, New York. Wm. H. Todd, president, Todd Shipyards Corporation, New York. H. A. Wheeler, vice-president, Union Trust Company, Chicago, Ill. F. W. Wood, president, Maryland Steel Company, Sparrows Point, Md.

At this meeting William H. Todd, president of the Todd Shipyard Corporation, New York, was elected third vice-president of the bureau, concluding the reorganization of the bureau. The personnel of the executive, classification and technical committees of the bureau will soon be announced.

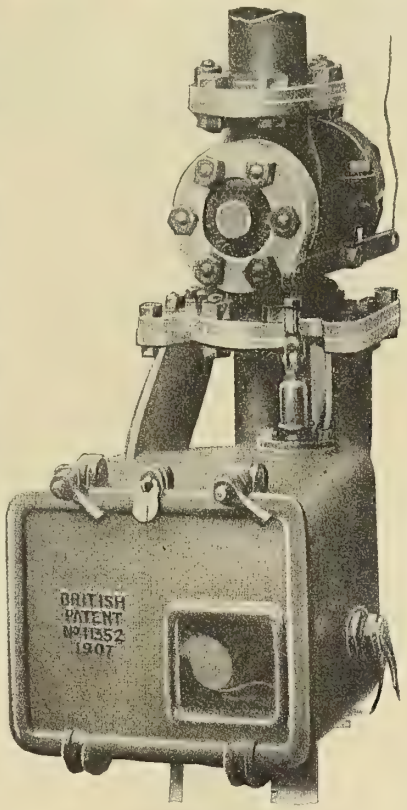
The management of the bureau has every reason to be encouraged by the general interest taken in the organization by shipbuilders, underwriters and shipowners, and it is confidently believed that in the next few years the bureau will achieve a very important and commanding position among the classification societies of the world by virtue of its efficient and valuable services to shipping and shipbuilding.



Submarine *Isaac Peral*, Built by the Fore River Corporation, Quincy, Mass., for the Spanish Government

The McNab Willett Bruce Steamship Whistle Control

In order that the steam whistle on any vessel may be as efficient as possible, it should be under absolute control, and installed in such a manner that no obstacle will make it inoperative, and so that the steam delivered to the whistle will be as dry as possible, insuring a clear, instantaneous signal. These results are obtained, it is claimed, by means of the Willett Bruce Steamship Whistle Control, manufactured by the McNab Company, Bridgeport, Conn.



Willett Bruce Whistle Control

The main operating valve admitting steam to the whistle is installed at the base of the whistle pipe adjoining the boiler casing. By this means the exposed part of the whistle pipe is kept free of steam, except when the whistles are in blast, thus reducing condensation to a minimum. Any steam condensed within the exposed whistle pipe during the working of the whistle falls by gravity, and is automatically drained off by a special automatic drain valve. The entire whistle pipe is therefore kept free from moisture, insuring a volume of dry steam to the whistle when the main valve is open, resulting in a clear, penetrating, crisp blast from the whistle under all conditions of weather.

The main steam valve is operated by a small pilot valve so that the energy required to open the main valve is reduced to a minimum and the blasts are instantaneous. The control of the whistle consists of electric and timing mechanism located in a control box placed immediately below the main operating valve. Both the time control and signal control are operated from the navigating bridge by means of special two-way switches. Three of these switches are installed with independent connection to the control box, so that the whistle may be operated from three positions on the bridge. An independent hand lanyard control is also provided to act as a stand-by in case of failure of electric power.

Motor Ship Sebastian Gives Satisfactory Service

On a recent voyage from Rouen, France, to New York, the motor ship *Sebastian*, of about 6,600 tons displacement and 4,100 tons cargo capacity, equipped with Werkspoor four-cycle Diesel engines of 1,650 brake horsepower, averaged a speed of 8.8 knots and consumed 6 tons of Solar fuel oil per 24-hour day on the voyage.

The *Sebastian* is a twin-screw vessel, 310 feet long, 45 feet beam and 26 feet 3 inches depth, built by the Caledonia Shipbuilding Company for Lane & McAndrew. When first built, the *Sebastian* was fitted with two 800 brake horsepower, two-cycle step-piston Diesel engines, built in Sweden, but owing to unsatisfactory service these engines were removed by the owners and replaced with the present four-cycle type Werkspoor Diesel engines.

One of the advantages of Diesel-engine drive in this vessel is shown by the fact that a total of 4,100 tons of cargo can be carried exclusive of fuel and stores on a displacement of only 6,600 tons, whereas with steam power the displacement of the boat to carry the same amount of cargo would have to be increased to from 7,000 to 7,500 tons.

MARINE ARTICLES IN THE ENGINEERING PRESS

The Present Position of the Marine Diesel Engine and Its Possibilities.—By Engineer-Lieutenant Commander W. P. Sillince, R. N. (retired). Abstract of paper read before the Institution of Naval Architects, April 13. General review of the development of the marine Diesel engine and forecast as to its future economical application to the propulsion of vessels of various classes. 6,000 words.—*The Engineer,* April 14.

Shipyard Cranes of the Rotterdam Dockyard Company.—By M. G. De Gelder. Abstract of paper read before the Institution of Naval Architects, April 13, describing all-around swinging type of cranes designed to run alongside the shipbuilding berths on top of lattice girders supported by columns. Capacity of cranes 3 tons at radius of 72 feet and 7½ tons at radius of 29 feet 6 inches. 3 illustrations. 3,250 words.—*Engineering,* May 5.

Spur Gearing.—By Daniel Adamson. Paper read before the Institution of Mechanical Engineers, London, May 19, 1916, discussing tooth shapes and proportions and materials for the construction of spur gearing, the allowable working stresses, maximum speeds and durability. 16 illustrations; 2 appendices. 8,250 words.—*Transactions of the Institution of Mechanical Engineers,* May.

The United States Lightships Nos. 101 and 102.—Abstract of a paper by Mr. George C. Cook read before the International Engineering Congress of 1915 in San Francisco, describing the general arrangement and construction of two lightships of 360 tons displacement, designed in the Division of Marine Engineering of the United States Bureau of Lighthouses. 8 illustrations. 1,200 words.—*The Shipbuilder,* July.

On Reduction Gears.—By John H. Macalpine. Serial article discussing the various actions and errors which affect the distribution of stress along the teeth and the proper action of mechanical reduction gears. Reasons for adopting the floating frame to attain the best possible results and explanation of how theory points to the beneficial action of the floating frame in greatly diminishing the most important defects with reduction gears. Data showing how experience has fully vindicated the leading of theory. Interpretation of "power constant," and discussion of various questions regarding the design of teeth. Discussion of marine installations, showing in several cases the additional saving in weight and steam economy which can be effected by the rise of the power constant made possible by the use of the floating frame. 12 illustrations. 26,000 words.—*Engineering,* May 5, 12, 19, 26, and June 2, 9 and 16.

PERSONAL

Alfred J. Brooks, for many years a draftsman at the old Roach shipyard, Chester, Pa., has been made superintendent of the Morse Shipbuilding Corporation, Noank, Conn.

Lieutenant James W. Lee, for many years associated with the Skinner Shipbuilding Company, Baltimore, Md. (now the Baltimore Dry Docks & Shipbuilding Company), has been appointed by the American Bureau of Shipping as surveyor for the ports of Norfolk and Newport News, with headquarters in Norfolk.

James V. Beekman, one of the founders of the Lidgerwood Manufacturing Company, New York, died at his home in Plainfield, N. J., in September 13, at the age of seventy-four.

Arthur T. Busch, formerly superintendent of the New Jersey Dry Dock Company, has been appointed manager of the shipyard of the Samuel T. Moore & Son Corporation, Elizabeth, N. J.

George C. Shepard, recently general manager of the Poole Engineering & Machine Company, Baltimore, Md., has opened an office in Baltimore as a consulting engineer for marine surveying and the design and superintendence of construction and alterations and repairs to vessels. In 1000 Mr. Shepard took charge of the engine design of the marine department of the Maryland Steel Company, Sparrows Point, Md., and in 1908 was made chief engineer of the marine department of this company, a position which he held until 1912, when he became superintendent of the American-Hawaiian Steamship Company, New York. After two years of service with this company, Mr. Shepard became associated with the Poole Engineering & Machine Company as general manager, as noted above, finally severing his connection with this company in order to devote his entire time to the general practice of marine engineering.

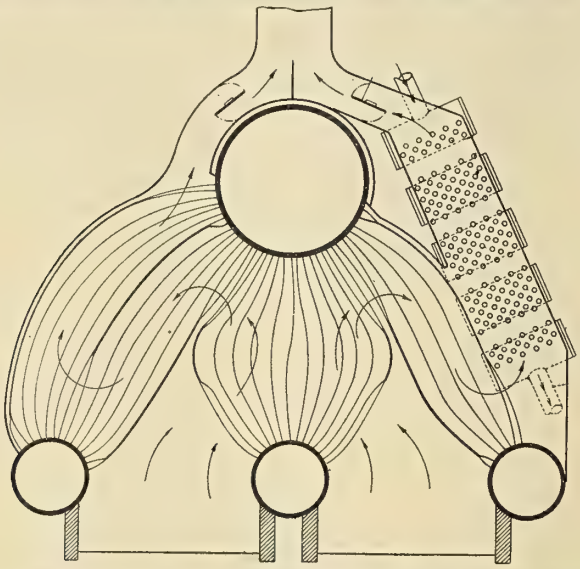
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,179,412. MARINE WATERTUBE BOILER AND SUPERHEATER. JULIUS EGGERS AND PETER THOMSEN, OF CASSEL-WILHELMSHOHE, GERMANY, ASSIGNORS TO SCHMIDT'SCHE HEISSDAMPF-GESELLSCHAFT, M. B. H., OF CASSEL-WILHELMSHOHE, GERMANY, A CORPORATION OF GERMANY.

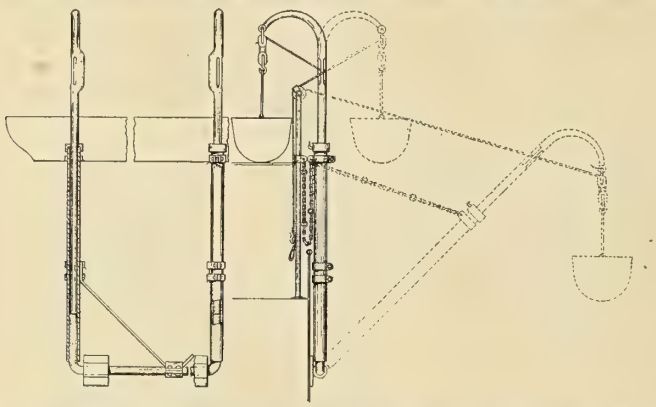
Claim 1.—In a marine boiler, a laterally disposed superheater comprising two groups of distributing and collecting heads respectively, at



least one of said groups being outside of the boiler casing, and groups of inclined tubes running lengthwise of the boiler between the header groups so as to form a set of series connected groups of tubes. Four claims.

1,180,322. SHIP'S DAVIT. EDGAR F. SANFORD, OF ALAMEDA, CAL.

Claim 1.—A davit comprising a rotatably mounted horizontal member having its ends upturned; a vertical tubular member fitted over each of said up-turned ends and affixed thereto; a vertical crane-member freely



fitted within each of said tubular members to leave a space therein for a lubricant and adapted to rotate on its axis within said tubular member; a cap at the upper end of each tubular member to retain the lubricant therein and to exclude water therefrom; and means for controlling the rotation of said horizontal member to cause the entire structure to swing outwardly and downwardly. Two claims.

1,179,440. STEERING APPARATUS FOR TORPEDOES. FRANK M. LEAVITT, OF SMITHTOWN, N. Y., ASSIGNOR TO E. W. BLISS COMPANY, OF BROOKLYN, N. Y., A CORPORATION OF WEST VIRGINIA.

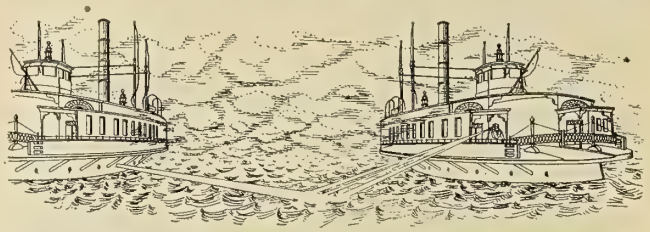
Claim 1.—In an automobile torpedo, the combination with steering means of primary and secondary controlling means, such primary means being adapted to operate upon the launching of the torpedo, and such secondary means being adapted to operate subsequently, and shifting means for transferring the control from the primary to the secondary means after the torpedo has reached its ultimate course. Three claims.

1,180,861. SUBMARINE BOAT. WILLIAM R. MACKLIND, OF CLEVELAND, OHIO.

Claim 8.—A submarine, comprising a plurality of hulls provided with bulkheads, a supporting structure interposed between and connected to said hulls and provided with longitudinally and transversely extending passages, said transversely extending passages communicating with said hulls. Thirty-three claims.

1,184,783. MEANS FOR OBSERVING AND SIGNALING BETWEEN SHIPS IN FOG. JAMES BUCKNER SPEED, OF WEST NEW BRIGHTON, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO WESTERN ELECTRIC COMPANY, INCORPORATED, A CORPORATION OF NEW YORK.

Claim 1.—Means for signaling and observing between ships in fog, comprising means carried by each ship for projecting light outwardly from the ship near the surface of the water; means for intermittently cutting

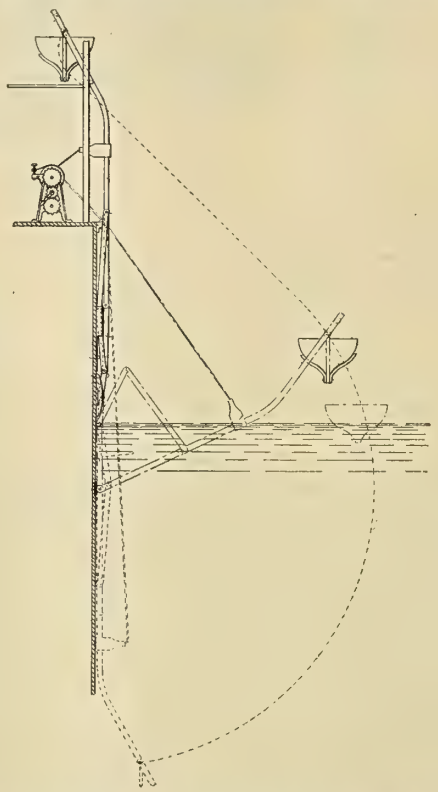


off projection of said light; and means, operating in synchronism with said last-mentioned means, for preventing an observer located on a ship near the surface of the water from observing the effect of light from other ships except during the intervals when the projection of light from his ship is cut off. Three claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn place, W. C., London.

9,115/15. APPARATUS FOR RAISING AND LOWERING SHIPS' BOATS. J. STORIE, OF 2, ROSSIE PLACE, IN THE CITY OF EDINBURGH, SCOTLAND.

The object is to provide an improved apparatus of simple construction which, among other advantages, will render it possible to launch boats from either side or both sides of a ship which by accident or otherwise has been caused to have a serious list; to launch boats safely in rough weather, or while the ship is rolling; and also while the ship is moving at a moderate speed. The invention relates to that kind of apparatus which comprises a cradle, or the like, adapted to support a boat by pivotal or other supports at each end, and arms adapted to support the said cradle, the said arms being substantially vertically disposed down the sides of the ship and pivotally mounted at their lower ends, and means whereby the arms may be turned in a vertical plane about their lower



ends. In arrangements of this class when it is required to launch a boat the arms are allowed to swing down, pivoting about their lower ends so that the cradle, which is supported between the upper ends, is swung wide of the side of the ship until the boat carried thereon reaches the water, when it automatically floats free of the cradle. In the improved apparatus the lower end of each arm is pivoted to a link, which itself is pivotally attached to the side of the vessel, whereby, when the apparatus is released or lowered, the boat will move in a downward direction even with a considerable degree of list on the ship. A pin or roller is provided near the upper end of each arm adapted to slide up or down in contact with a fixed substantially vertical member carried by the vessel, and the upper ends of the arms are bent inwardly so that the boats normally hang within the vessel's side. The link work is so designed that the boat automatically takes a downwardly inclined and practically straight path away from the vessel's side, and subsequently takes a path consisting of an arc of a circle.

INTERNATIONAL

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Bulkhead and Load Lines Committee

THE following committee of shipbuilders, naval architects and ship owners has been designated as a result of the conference on September 27 at the office of Secretary Redfield, Department of Commerce, to consider the questions of bulkheads and load lines and report to Secretary Redfield at a later date: Stevenson Taylor, of New York, president of the American Bureau of Shipping and president of the American Society of Naval Architects and Marine Engineers; H. C. Sadler, Ann Arbor, Mich., professor of naval architecture, University of Michigan; H. N. Herriman, Cleveland, Ohio; C. J. Olson, San Francisco, Cal.; H. H. Raymond, New York, manager Clyde & Mallory Steamship Companies; T. M. Cornbrooks, Sparrows Point, Md., chief engineer and naval architect, Bethlehem Steel Company's Maryland Shipbuilding plant; William Gatewood, Newport News, Va., naval architect, Newport News Shipbuilding & Dry Dock Company; W. A. Dobson, Philadelphia, Pa., naval architect, Wm. Cramp & Sons' Ship and Engine Building Company, and J. W. Powell, Quincy, Mass., president, Fore River Shipbuilding Corporation.

The date and place of the first meeting of the committee will be arranged by Mr. Stevenson Taylor.

Naval Architects' Meeting

WITH the renewed interest in shipbuilding and shipping aroused in engineering and financial circles by the unprecedented boom in shipbuilding in the United States, the forthcoming meeting of the Society of Naval Architects and Marine Engineers in New York on November 16 and 17 should bring out the largest attendance in the history of the society. At no time in the twenty-four years since this society was organized has the need for experienced men trained in the science of naval architecture and marine engineering been more urgent. Not only are the existing facilities for shipbuilding in the country taxed to their utmost capacity to meet the steadily increasing demands for both merchant and naval vessels, but new shipyards are being established and manufacturers of machinery and marine specialties are finding in the marine field an extremely profitable outlet for their products. With the increased output in the shipyards has also come a remarkable period of scientific development which virtually marks an epoch in shipbuilding. The wide application of geared turbines to the propulsion of merchant vessels, the adoption of electric drive on large naval vessels of enormous power, the commercial introduction of the heavy oil internal combustion engine and the recent development of the hundred and one other distinctly marine lines of engineering progress have practically revolutionized marine engineering practice. As new methods and new data continually become available, the value and importance of such an institution as the Society of Naval Architects and Marine Engineers become apparent. In view of the comparatively few opportunities offered in the United States for the discussion of professional subjects relating to the building and operation of ships, the coming meeting of the naval architects with its diversified programme should be well attended and every effort should be made to increase the membership of the society, so that when in another year the society shall have rounded out a quarter century of service in this field it will fully represent the importance of this most exacting profession to the country.

Future Needs of Shipping

BESIDES the actual destruction of merchant shipping due to the European war and the rapid deterioration of the immense fleets of merchant vessels commandeered for war purposes by the belligerent nations, as outlined on another page of this issue, there are other aspects of the situation that make the continued activity of the shipbuilding industry in neutral countries and elsewhere inevitable.

In the first place, there is little likelihood that any of the belligerent nations can resume a normal output of merchant tonnage until peace is declared, and regrettable as the circumstances are there are no apparent indications of a cessation of hostilities for many months to come. In Great Britain, for instance, which hitherto has been the greatest shipbuilding center of the world, the output of merchant tonnage in 1915 was only one-half the normal output, while in the same year the losses to the British merchant marine exceeded the average output in the years immediately preceding the war. In the other belligerent nations without exception the conditions are worse. Meanwhile the international commerce of the world, after its depression in the early months of the war, is again nearly normal in value, although owing to increased prices and cost of transportation the volume is probably less than in 1913.

Radical changes, however, have occurred both in the classes of commodities and in the relative movement of international trade. In the nations at war there has been a striking falling off of exports, particularly of manufactured products, but an enormous increase of imports, chiefly of foodstuffs, materials and war supplies. On the other hand, in neutral countries generally the conditions have been reversed with a corresponding increase in exports and a falling off in imports. Moreover, the movement of the world's commerce is gradually being shifted into the hands of marine interests hitherto unable to compete for this trade. This readjustment, of course, is contingent in a large measure upon the duration of the war, and as soon as the warring nations return to peaceful pursuits home products will again become a factor of increasing importance, and both the nature and distribution of international commerce must again be readjusted.

The restoration of peace, however, will not mean the immediate release to international commerce of the enormous fleets of merchant vessels commandeered by the

governments at war. A long period of restoration will be at hand. The transport of troops, materials and supplies will require the continued use for many months of a large portion of the tonnage already in government service. Restoration of the devastated lands in the war zone and the resumption of engineering and manufacturing projects long held in abeyance by the war will immednately call for the transportation across seas of enormous quantities of materials and manufactured products, and the demand for merchant tonnage will in all probably tend to increase rather than lessen.

Bids for New Warships

BIDS were opened at the Navy Department on October 25 for the construction of the battleships *Colorado, Maryland, Washington* and *West Virginia,* and the twenty destroyers authorized last August in the naval appropriation act. Further bids for the four 35-knot battle cruisers and twenty submarines authorized in the same act will be opened on November 1.

All of the bids for the battleships were within the $11,500,000 (£2,360,000) limit set by the government, ranging from $10,060,000 (£2,060,000) to $11,475,000 (£2,350,000). The minimum time of completion, however, was thirty-nine months for one ship and forty-five months for all four ships.

Five yards submitted bids for the destroyers, but one bid from the Seattle Construction & Dry Dock Company, Seattle, Wash., was thrown out, as it was above the limit of $1,200,000 (£246,000) set by Congress. The bids ranged from $1,150,000 (£236,000) to $1,195,000 (£245,000) and the time of delivery from twenty-two to twenty-eight months.

It is believed that the Fore River Shipbuilding Company, Quincy, Mass., and the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., will each be awarded contracts for two of the battleships, although there is a possibility that the contract for one of the vessels may be given to the New York Shipbuilding Company, Camden, N. J. The Bath Iron Works, Bath, Me., the Union Iron Works, San Francisco, Cal., the Fore River Shipbuilding Company, Quincy, Mass., and the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., will in all probability get the contracts for the destroyers.

The unusual conditions prevailing in the shipbuilding industry to-day were reflected in the proposals offered. In the first place the William Cramp & Sons Ship & Engine Building Company offered to build one battleship on a basis of cost plus ten percent commission, a proposal which could not be legally entertained in the case of a battleship, but which will be permissible in the case of the battle cruisers, bids for which will be opened on November 1. A somewhat similar proposal was also submitted by the California Shipbuilding Company, Long Beach, Cal., for the construction of destroyers.

This company offered to rent its shipbuilding facilities to the government for building several destroyers according to government plans and specifications on the general basis that the government deliver to the company at its plant the materials for the vessels, pay the actual cost of all labor and materials, and compensate the company for the general use of its shipbuilding berths, machinery and general supervision over the construction. This proposal was made because of the uncertainty in obtaining definite delivery of materials on the Pacific coast and because of the present unstable condition of the transcontinental freight tariffs which before the completion of the contract may increase the cost of transportation of materials to the builders' plant by as much as 40 percent.

In the proposals made by the Fore River Shipbuilding Corporation the difficulty of forecasting the probable cost of labor or materials over a period of years was met by stipulating that any increase or decreases in the prices of labor and material in the original contract which were based on the current rates of labor and material at the builders' yards should be investigated by the United States Federal Trade Commission at the end of each year and the contract price of the ships increased or decreased by corresponding amounts for the year. The reasons for making this proposal were explained by the company as follows:

Because of the present unprecedented activity in all lines of business it has not been feasible to cover by option or provisional contract more than 50 percent of the total material required. The balance must be purchased at different times during the succeeding three or four years. Should prices for materials increase during this period, as they have in the last twelve months, the cost of the materials required for the completion of the vessels would be more than double what it is to-day. Further, of an even more unstable character is the second of the two primary elements entering into the cost of shipbuilding to-day—that is, the wages. In ordinary periods of the past improved methods of construction and additional facilities have offset normal increases in wages; but within the last twelve months wages have risen at such a rate as to show costs in connection with vessels now completing above any figures which could have been expected at the dates the contracts were undertaken.

The company also pointed out that the contemplated profits in the estimates proposed represent but a fractional part of the margin obtainable to-day in all contracts for the building of merchant ships. Notwithstanding the demands for merchant vessels the company, fully recognizing the emergency confronting the United States, has for eight months past refused all contracts and has reserved a substantial capacity for such work as the Navy Department may desire to allot to it.

Why the Navy League is Interested in the Re-establishment of the Merchant Marine

That the re-establishment of the merchant marine is second only in importance, in the minds of believers in preparedness, to provision for an adequate navy is an assertion made by *Sea Power,* the official publication of the Navy League. It therefore calls upon all those who have fought for adequate ships of war to join with it to get ships of peace that may become feeders of the fleet in the great emergency. The statement follows:

The interest of the Navy League in the great question of a merchant marine is based primarily on consideration of naval necessity. A powerful navy and a large merchant fleet are complementary in a large degree. The navy must depend upon the merchant marine for auxiliary service in time of war, and, on the other hand, a great, flourishing commercial fleet competing for the world's trade requires ample protection.

A navy on a war footing is a vastly different thing from one on a peace footing. In times of peace, with the fleet in home waters, the supply of fuel, food, clothing, ammunition, etc., is a comparatively easy matter. Navy yards and fuel depots are close at hand, and only a very few

auxiliary vessels, comprising colliers, oil-tankers, refrigerator and supply ships, tenders, a repair ship and a hospital ship are needed. In war the fleet must not be tied to a home base, but must be foot-loose and free to carry its activities to any strategic point, possibly thousands of miles away. Then, not only must the train of auxiliaries accompanying the fleet be enormously increased, but there must be provided a steady stream of auxiliaries between the fleet and its base, for a fleet cannot exist without fuel and food, and cannot fight long without new supplies of men and ammunition. The demands of war would entail an increase in naval auxiliaries of literally hundreds of vessels, and if the army were involved in overseas operations it would require hundreds more.

Where are all these naval auxiliaries and army transports to be obtained? Obviously, no nation could afford to build and keep in idleness for an emergency such a fleet as would be required. Nor is it possible to buy or build them after the emergency arises. There is only one answer, our merchant marine must be large enough to furnish at need all the ships that may be required for war purposes, and in addition be able to carry on the commercial business of the country.

This necessity is secondary only to the fighting fleet itself; a fleet without a train might be utterly helpless. Hence our interest in the building up of the merchant marine.

When our people have learned the value of a merchant marine to the prosperity and well-being of the nation, and when our law makers have learned the ways and means of encouraging and fostering its growth, then the time will come when our factories and producers shall no longer have to depend upon their competitors to carry their wares to market and to supply us with raw material, and our fleet will not be tied to its base in the event of war. The expansion of our merchant marine must go hand in hand with the building of our navy. The two are equally important factors of sea power.

Will the Shipbuilding Boom Last Ten Years?

Destructive Effect of European War and Rapid Deterioration of Commandeered and Interned Vessels Insure Increased Demand for New Tonnage

BY H. L. ALDRICH *

WHEN the war broke out in August, 1914, the gross tonnage of the merchant marines of the world was approximately 50,000,000 tons.

Great Britain was credited with 21,045,049 tons. She has lost through destruction over 2,734,106 tons, leaving a balance of less than 18,310,943 tons. The government commandeered over 50 percent of the larger and more efficient vessels. Counting these as about 9,000,000 tons, it leaves only about 9,000,000 tons of British merchant vessels still in commercial service. The government is running the ships for all they are worth, so that if the war lasts two years more the commandeered ships will be fit for little else than scrap, except at enormous expense for repairs. The 9,000,000 tons of vessels still in the ocean trade will be largely old vessels of comparatively small carrying capacity, and more or less uneconomical and inefficient.

Effect of War on Merchant Tonnage

Germany was credited with 5,134,720 tons. She has lost over 600,000 tons, leaving a balance of less than 4,534,720 gross tons interned. These ships are deteriorating at the rate of 15 to 20 percent a year. Many of these are old vessels, so that this merchant marine will not be of much value at the end of two years more of war, except at enormous cost for repairs.

France began the war with 1,922,286 tons. She has lost over 309,023 tons, leaving a tonnage of something under 1,613,263. Like the other merchant marines, this one will require enormous expenditures to restore it.

The merchant marines of the other belligerents are correspondingly reduced in tonnage and efficiency.

At the outbreak of the war the United States was credited with 7,928,688 tons. Over 600,000 tons were added by foreign vessels coming under the American flag. Vessels under construction in shipyards to-day and those that have been delivered since the war broke out approximate 1,750,000 tons. American vessels lost during the war aggregate 63,580 gross tons, making the total American merchant marine in commission and under contract at least 10,215,108 tons.

Present Strength of World's Merchant Marine

Up to date the belligerent merchant marines have been reduced in tons about as follows:

Total tonnage, August 1, 1914		50,000,000
Destroyed	5,000,000	
Commandeered by British	9,000,000	
Commandeered by other belligerents	3,000,000	
Interned, Teuton Allies	4,400,000	21,400,000
Total		28,400,000

Two more years of war must of necessity result in the destruction of considerable more tonnage.

What might be called the tonnage-efficiency of the 16,400,000 tons of commandeered and interned vessels will be enormously reduced and require very large expense to keep any of it from the scrap heap.

It is apparent that with two years more of war the world's merchant marines will be considerably under 25,000,000 tons, and in tonnage-efficiency much below the standard of August 1, 1914.

How much new tonnage has been built outside of American shipyards since August 1, 1914, is only conjectured, but it is undoubtedly very small. No one can even approximate the tonnage that will be built in the next year or two.

According to Captain Robert Dollar, the shipyards of the world during the past fifteen years have built approximately 2,500,000 tons per year. Accepting this as a minimum capacity of the shipyards of the world, it will be seen that it will require pretty nearly ten years to bring the world's merchant fleets back to a sufficient tonnage to handle its world's commerce.

* President, Aldrich Publishing Company, New York.

NEW PLATE AND ANGLE SHOP AT FORE RIVER SHIPYARD, QUINCY, MASS.



Fig. 1.—View of Plate and Angle Shop, Looking East

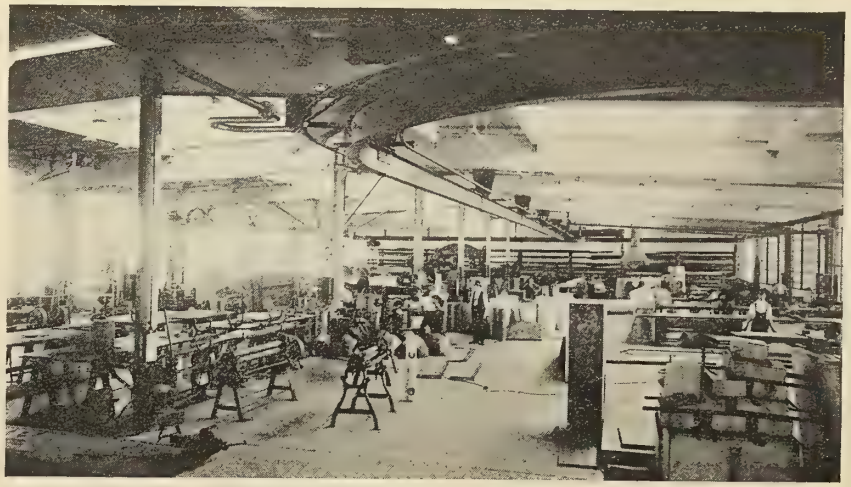


Fig. 2.—Sheet Metal Shop on Second Floor

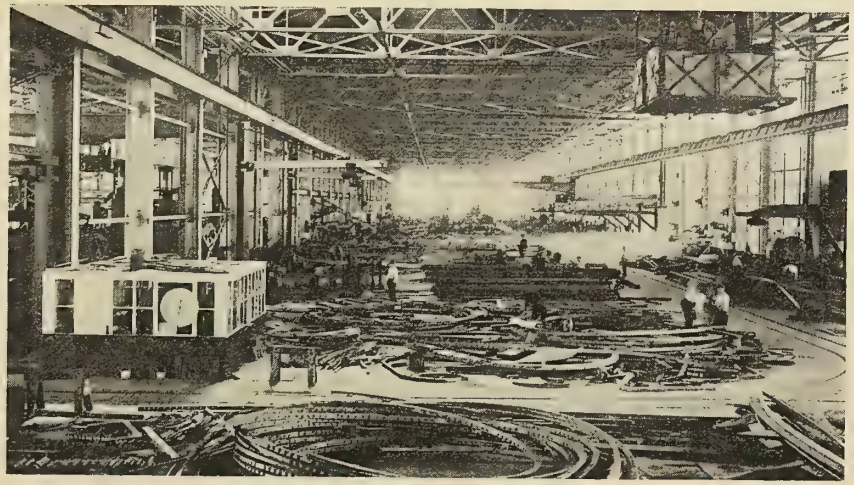


Fig. 3.—North Bay, Looking West

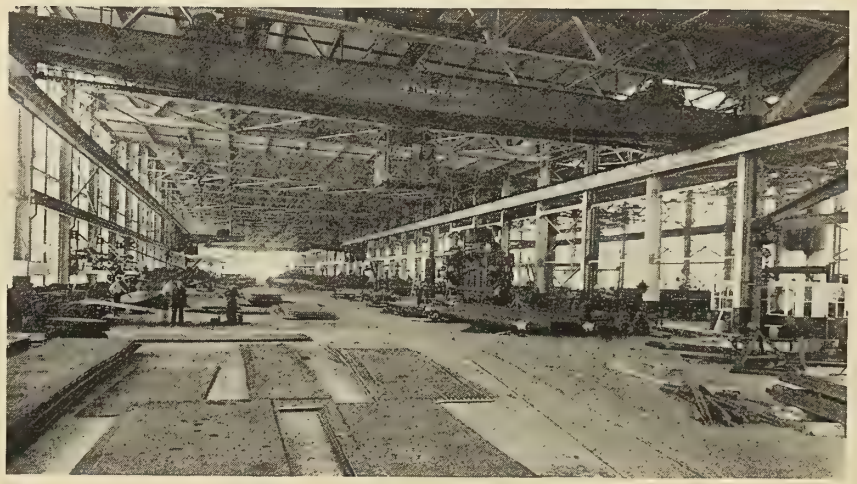


Fig. 4.—South Bay, Looking West



Fig. 5.—Mold Loft, Looking East

Huge Plate and Angle Shop and Mold Loft Completed at Fore River Shipyard

Two-Story Building, Covering Three and One-Half Acres, to House Hull Fabricating Department

WHAT is said to be the largest plate and angle shop in the world has recently been completed at the yard of the Fore River Shipbuilding Corporation, Quincy, Mass. The building is two stories in height, 769 feet long by 187 feet 10 inches wide, covering an area of 3½ acres.

The building lies east and west with a stock material yard lying north and south at the west end of the building. The stock yard receives all raw material for hull construction and is fitted with railroad tracks and gantry cranes. The majority of the stock is stowed flat and is lifted by means of magnets carried on gantry cranes. The material is conveyed from the yard into the shop by means of electric storage battery trucks, the plates being deliv-

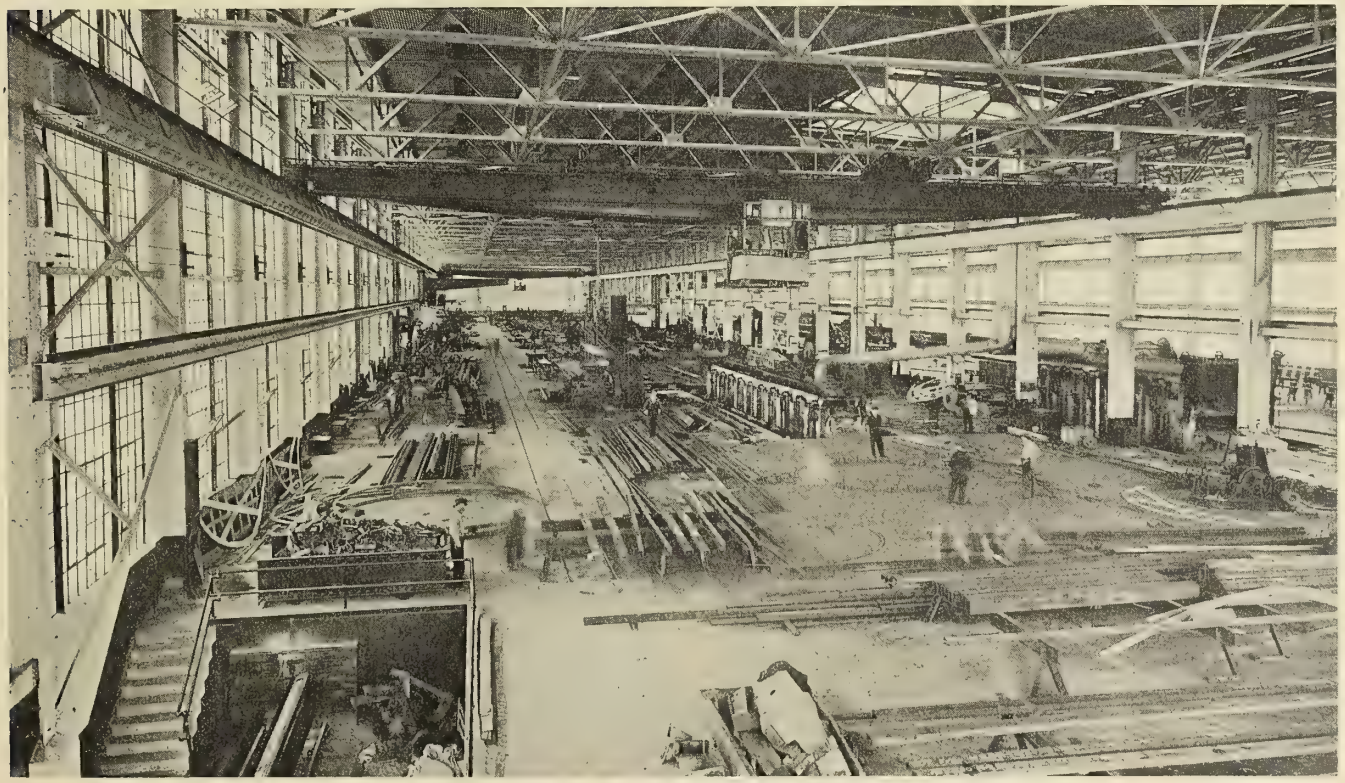
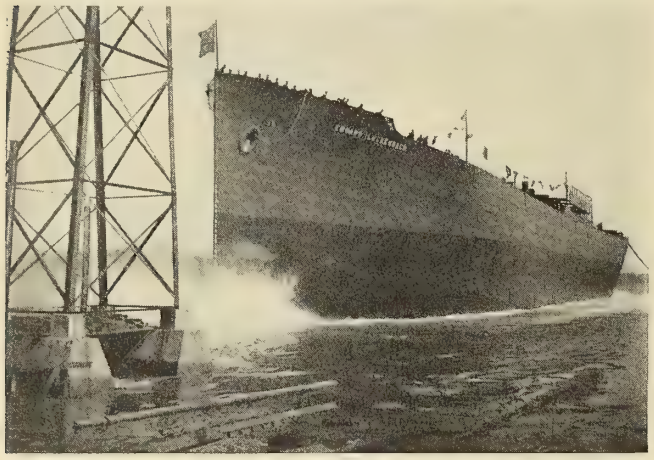


Fig. 6.—South Bay, Looking West

ered on one side of the building and shapes on the opposite side.

The building proper is divided into two parts by means of building columns, one side of the building being for plates and the other side for angles and beams, but both meeting at the east end, where the work is assembled and riveted before being put out of the shop for erection on the building slips. The electric storage battery trucks can go right through the shop from end to end and also out of the shop under the building slip cranes, all of which are located at the east end of the building, and run from east to west.

Eight of the latest type of floating punches, complete with automatic roller tables, are provided in the plate side of the shop. This side of the shop also contains the oil-burning furnaces for the heating of plates and the bending blocks. There are also two 35-foot, direct-driven



Launching of S. S. *Edward Luckenbach* at Fore River Shipyard

plate planers and one belt-driven planer, a set of straightening rolls, gate shears, countersinking machines, scarfing machines, a 25-foot, 500-ton hydraulic plate-bending machine, a hydraulic manhole punch, 35-foot bending rolls and other machinery.

The angle side of the shop is fitted with an oil-burning furnace for heating shapes and also with bending blocks and hydraulic presses for the bending of shapes to molds as required. The equipment of this part of the shop also includes the latest types of punches, bending machines, beveling machines, hydraulic juggling press, drills, countersinking machines, shears, beam bender and other machinery. At the east end of the building are laid out all the assembling skids with pneumatic bull riveting machines hung on cranes with oil-burning riveting forges nearby. Here all the work is assembled and riveted complete before leaving the shop.

The shop is fully served with 5-ton cranes running on each side of the shop and with two trolley-type, 15-ton overhead cranes and also independent jib cranes with electric hoists and post cranes. All machines in the shop are independent, electrically driven, and all can be controlled from the switchboard room in the building from which all the electric power is controlled. The building is heated by hot water, the heat being obtained from exhaust steam.

The second floor, which is reached by means of elevators, one on each end of the building, contains a mold loft and sheet metal working shop. The mold loft is 605 feet long by 93 feet wide, with a storage ell of 4,000 square feet. This loft is for the laying down of ships to full size, and is believed to be the largest mold loft in any shipyard in the world.

The sheet metal working shop is 164 feet long by 93 feet wide, with an ell 93 feet long by 41 feet wide. This shop is served by a combined passenger and freight elevator and also by an electric monorail hoist which travels from one end of the shop to the other. The machinery is all of the latest type, including power presses, rolls, punches, shears, drills, electric spot welding machines, etc.

Under the second floor and suspended from its floor trusses are groups of offices at each end of the building. Wash rooms, locker rooms, toilets and shower baths are also provided for the workmen.

Geared-Turbine Freight Steamship Launched at Fore River Shipyard

A notable addition to the fast-growing mercantile fleet of the United States was launched on September 14 from the yard of the Fore River Shipbuilding Corporation, Quincy, Mass., in the S. S. *Edward Luckenbach* for the Luckenbach Steamship Company, of New York.

This vessel, which has been designed to the owners' special requirements for coast to coast and overseas trade, is of the following dimensions:

Length over all	456 feet 6 inches
Length on waterline	449 feet 3 inches
Beam, molded	57 feet
Depth, molded	41 feet 6 inches
Deadweight carrying capacity	about 10,000 tons

The *Edward Luckenbach,* in the adoption of the modified cruiser stern, the novel arrangement of bridge and deck house bulwarks and one large smokestack amidships, and the two masts and eight kingposts, inaugurates for this rapidly growing fleet a handsome vessel of distinctive appearance and individuality that will be readily recognizable both at sea and in port.

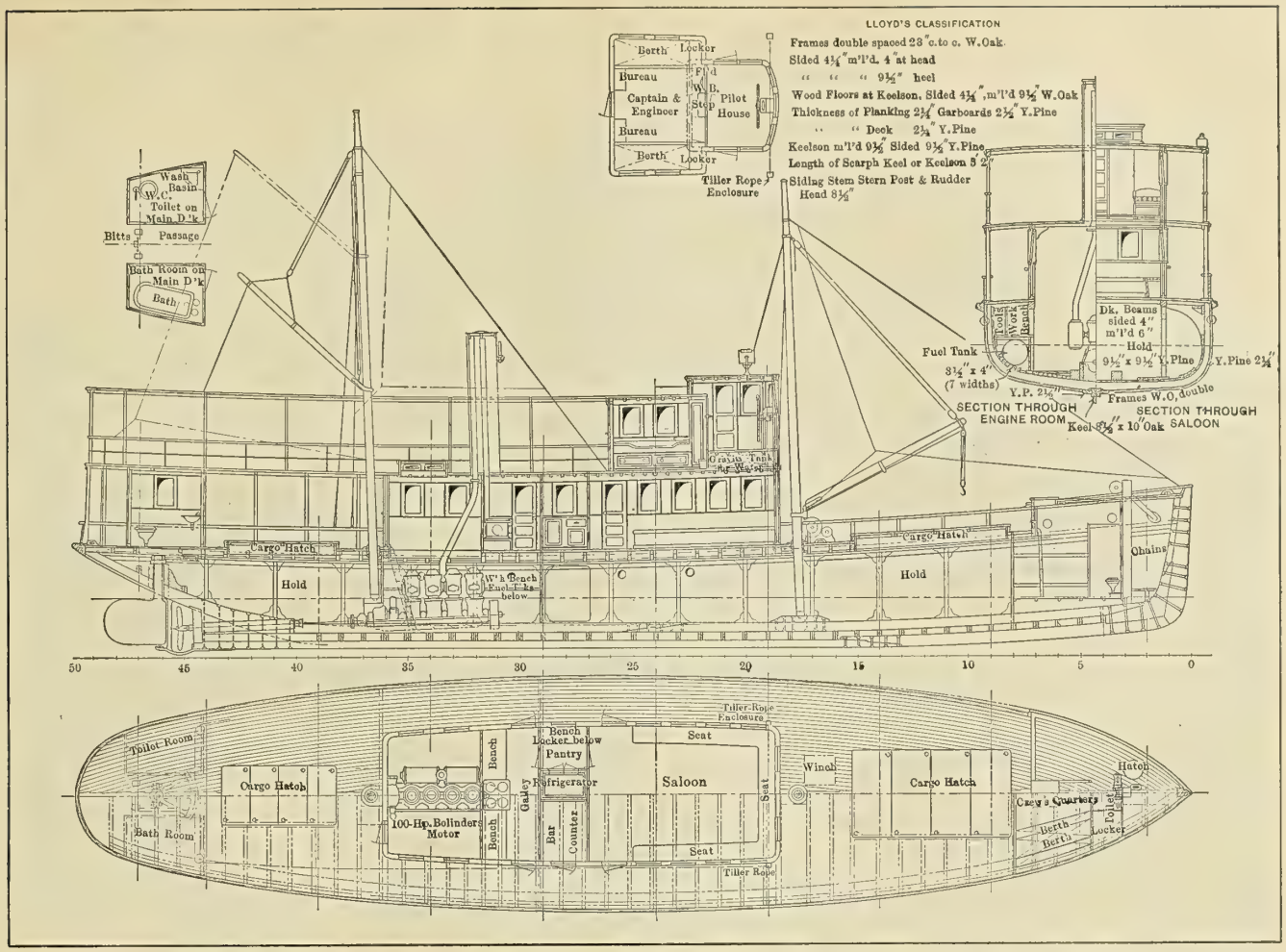
She is the first of five steamers now under construction by the Fore River Shipbuilding Corporation for the Luckenbach Line, and is a vessel of the shelter-deck type with wide-spaced hold stanchions, no side stringers, and wide-spaced frames designed for the economical carriage and rapid handling of general freight.

She has been built under the special survey and to meet the full requirements for hull, equipment and machinery of both the American Bureau of Shipping and Lloyds Register of Shipping, and will obtain the highest classification ratings, with freeboard assignment, in the records of these societies.

The propelling machinery consists of a single Curtis turbine, driving a high and low speed reduction gear designed to deliver 4,000 shaft horsepower at 90 revolutions. The maximum shaft horsepower will be 4,500, with the revolutions of the propeller not exceeding 93, and the turbine is designed to work with a steam pressure of 195 pounds in the steam chest and against a vacuum of 28 inches.

The turbine is so arranged that the head and reverse turbines are carried on one shaft and contained in one casing. The astern turbine will be capable of delivering to the shaft not less than 50 percent of the power of the ahead turbine.

The total reduction of speed between the turbine and propeller shaft will be in two steps known as the double-drive type; that is, pinions will drive two gears, one diametrically opposite the other, thereby eliminating the pressure on the pinion bearings. The high-speed pinion will be directly connected to the turbine shaft by means of a flexible coupling so arranged that any actual motion in the gears or pinions will not be transmitted to the tur-



General Plans of Wooden, Shallow Draft Passenger and Cargo Motor Boat. Designed for South American Owners

bine shaft. Each wheel will carry a right and left helical shaft gear. The low-speed reduction gear will consist of a large gear wheel driven by two pinions, each pinion being driven through a flexible connection by one of the wheels in the high-speed gear casing.

The propeller is 19 feet in diameter with blades set at a pitch of 16 feet; the pitch, however, being adjustable between 15 and 17 feet. The propeller hub is of cast iron and the blades manganese bronze.

Steam is furnished by three single-ended Scotch marine type boilers, each 16 feet 6 inches inside diameter and 12 feet 3 inches long, having a total heating surface of about 10,500 square feet. Each boiler has four Morison corrugated furnaces 42 inches inside diameter and is arranged to burn fuel oil on the Dahl system, the necessary pumps, filters, heaters, etc., being arranged in the fireroom. Fuel oil for the boilers is carried in the double-bottom compartments and the forward and after peak tanks.

The quarters for the officers and crew have received special consideration to insure good light and ventilation, together with comfort and habitability, and in these respects these vessels leave little to be desired.

American-Designed Working Boat for Cartagena, Columbia

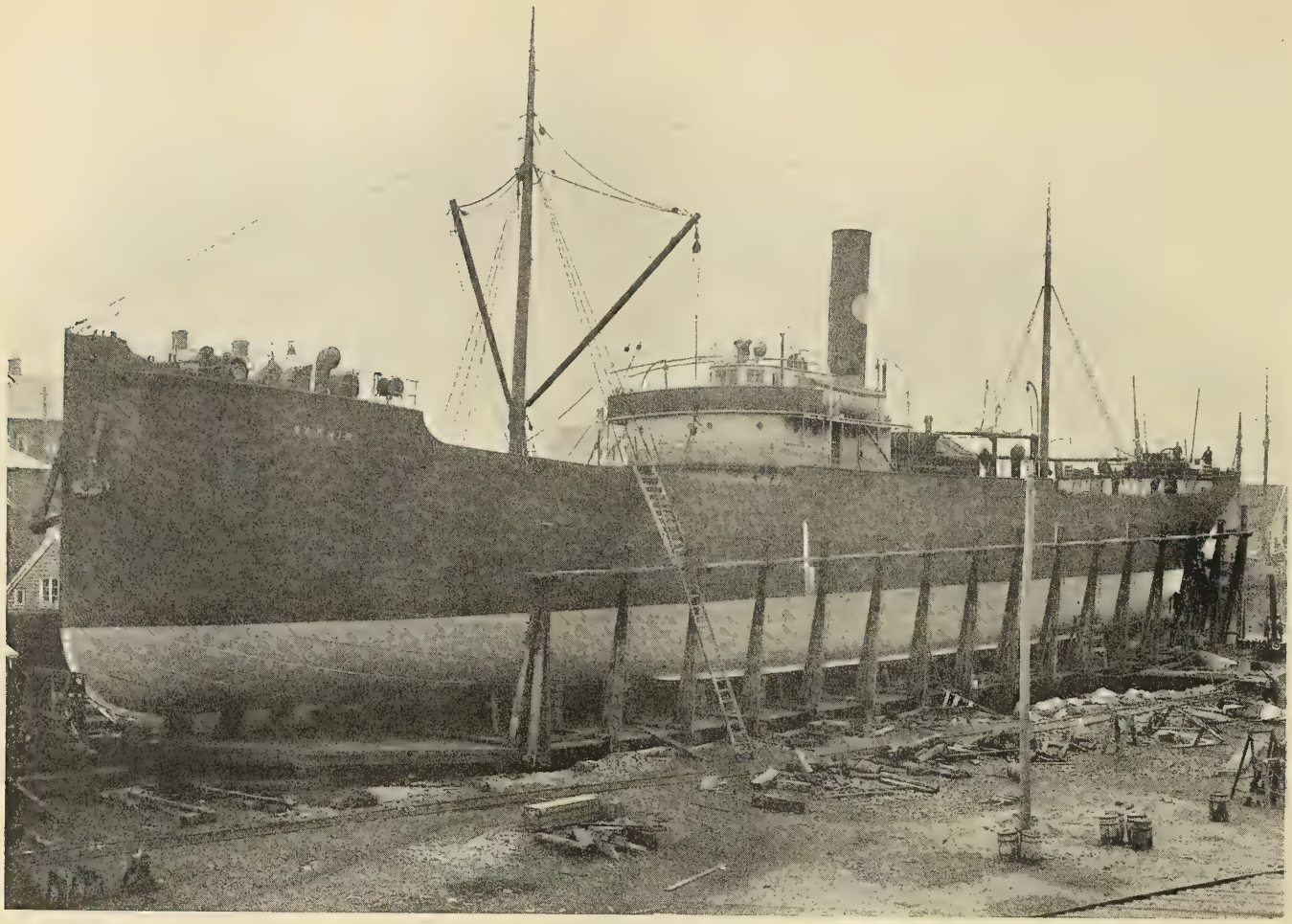
A 95-foot, shoal draft working boat to be called the *Sinu* is now being built by the Cartagena Shipyard, from designs by J. Murray Watts, naval architect, Philadelphia, Pa., for F. A. Scharberg, of Cartagena, Columbia, S. A. The dimensions are: 95 feet length over all, 90 feet length on waterline, 20 feet beam and 4 feet 6 inches draft. Propulsion is by a 100-horsepower, heavy-duty Bolinders oil engine. The boat will be used for transporting cargo and passengers up and down the river from Cartagena.

There is a good-size saloon for passengers in the deck house and plenty of room for cargo in the forward and after holds. On the upper decks are quarters for the captain and engineer, as well as the pilot house, and a covered promenade deck for passengers. A powerful electric plant is installed, which not only operates the incandescent lights and searchlight, but also the electric windlass for handling the cargo.

Another very similar boat to this, but with somewhat greater draft, is now being designed for Dr. C. A. Campbell, of Kingston, Jamaica. These boats show very clearly the tremendous strides that the oil engined motor boat is making in South America and the West Indies.

Crandall Railway Dry Docks in Scandinavia

Perhaps it is not commonly known that the type of marine railway familiarly known in the United States as the "Crandall Railway" and which is really a dry dock operated upon the inclined plane principle, has made itself known nearly all the way around the world. These railway dry docks have been built as far West as the Hawaiian Islands and the Philippines, and as far East as Piræus, Greece. Four of them are located in Scandinavia. The first of these is at Stavanger, Norway, with a capacity of 500 tons. The second was designed for parties



Crandall Railway Dry Dock of 1,800 Tons Capacity, Built at Haugesund, Norway

in Frederickshavn, Denmark, and is of 600 tons capacity. The third of 1,800 tons capacity, was built in Haugesund, Norway, in 1907.

The fourth, now about completed, is at Bergen, Norway, and has a capacity of 1,500 tons. The track is of the three-way type resting on a foundation of concrete placed on bed rock. The main dock, or "cradle," is framed entirely of riveted steel, making a strong and rigid structure to carry the vessel. The cradle, like all those of the Crandall type, carries a floor, the same as all other dry docks, over its entire length. Keel blocks, as usual, are of wood, 3½ feet high, over the main portion of the length of the dock, decreasing a little in height at the ends. The line of keel blocks has an incline of 1 foot in 44 feet. At mean high tide there are 12 feet of water forward and 17 feet aft over the keel blocks, when the cradle is all the way down. The cradle itself is 236 feet long and 50 feet wide. There are thirteen sliding bilge blocks on each side of the dock. These bilge blocks are run in and out of position by means of hand winches located upon docking platforms, which are always above water.

The cradle is operated by four 1⅞-inch special sprocket chains, each having a breaking strength of 230,000 pounds. The four chains are equipped with a patent compensating device for equalizing the load between them. They are driven by an electrically operated hoist equipped with an induction motor of 125 horsepower. A full load of 1,500 tons can be hauled up upon the cradle in twenty minutes. All of the chains and hauling machinery were made in the United States.

Destructive Storm Damages Shipping and Waterfront Property at Mobile

On the morning of July 5 a severe tropical storm swept over the city of Mobile, Ala., raging for twenty-four hours and doing several million dollars' worth of damage in and around the city. The wind reached a maximum velocity of 107 miles per hour, and throughout the storm maintained an average velocity of 85 miles per hour.

Although the loss of life is believed to be less than



Fig. 1.—Wreck of Boats *Beaver* and *Pleasure Bay*

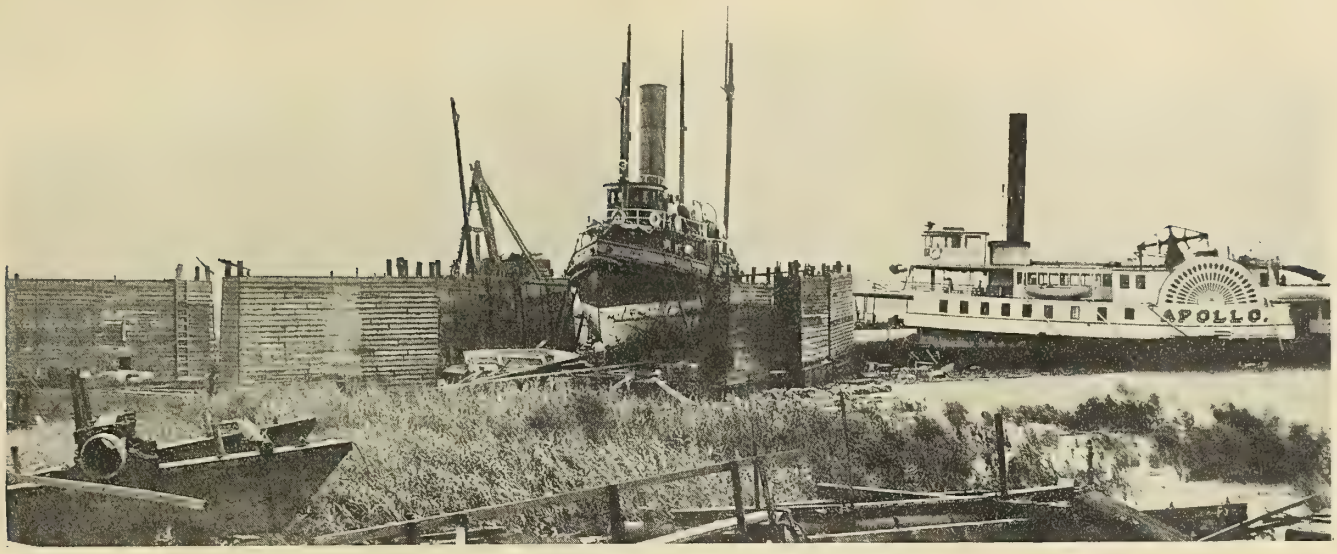


Fig. 2.—Tug *Gulfport* in Dry Dock Blown Two Miles Up Mobile River

twenty persons, practically every building in the city suffered more or less damage. The water in Mobile Bay rose 27 inches higher than during any previous storm on record, attaining a height of 8 feet in a large portion of the wholesale business district and ruining thousands of dollars' worth of merchandise.

Two river boats were perched up on the municipal docks, while several bay steamers and schooners were either wrecked or sunk. A large portion of the railroad docks were destroyed, and more than 5,000 bales of cotton



Fig. 4.—U. S. Snag Boat *William J. Twinning*, Stranded on M. & O. R. R. Wharf



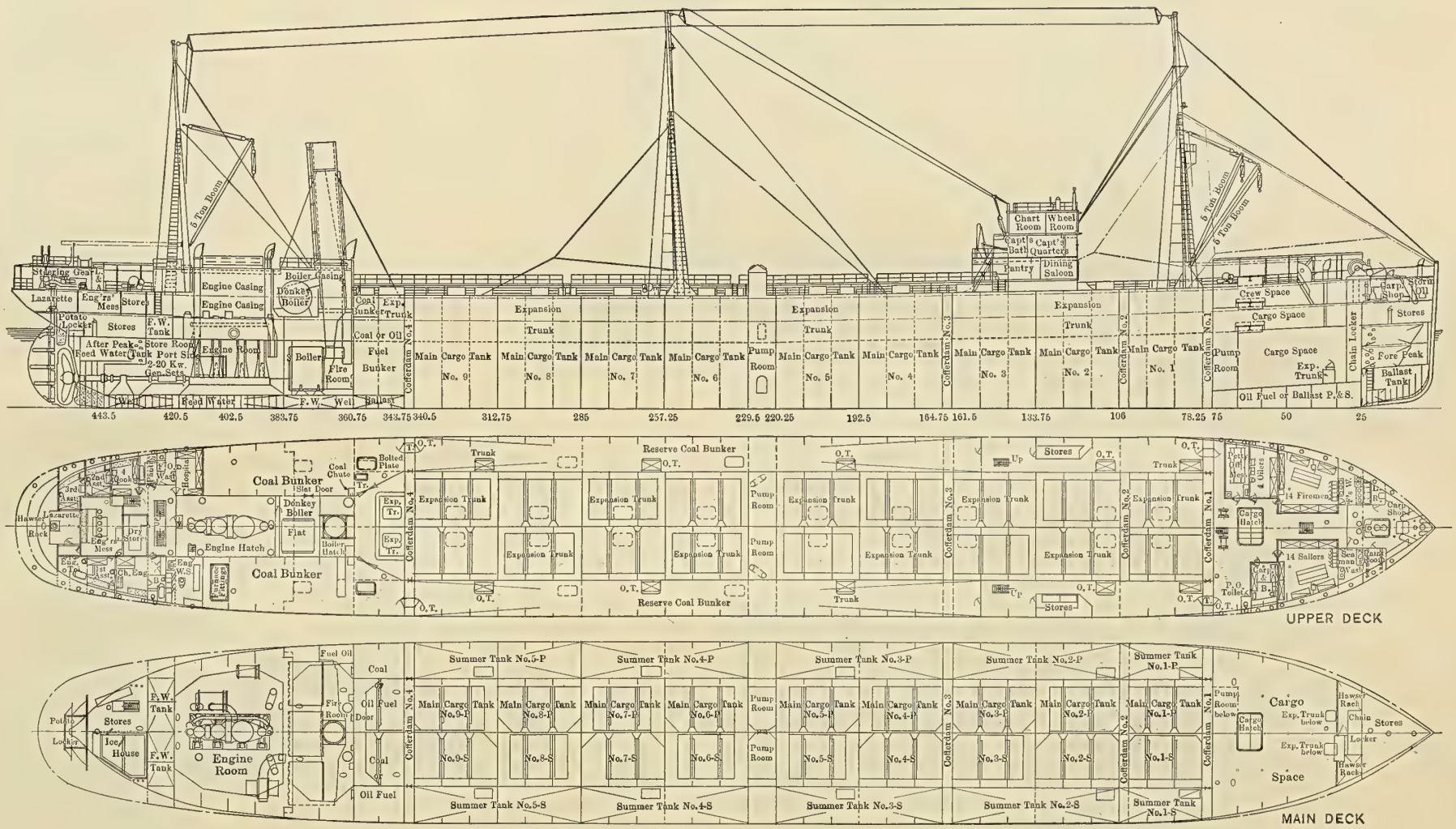
Fig. 3.—Russian Ships *Frieda* and *Grace Harward* Blown on Docks of Texas Oil Company



Fig. 5.—Excursion Steamer *Charles E. Cessna* Stranded on L. & N. R. R. Wharf

LONGITUDINALLY FRAMED OIL TANK STEAMER ANTWERPEN

Built by Newport News Shipbuilding & Dry Dock Company



Profile and Deck Plans of S. S. *Antwerpen*

and much timber that was on the wharves at the time the storm began floated about the business section of the city, while some was carried out into the bay and down to the Gulf.

The tug *Gulfport* in the sectional dry dock of the Ollinger & Bruce Dry Dock Company, shown in Fig. 2, was blown a distance of about two miles up the Mobile river during the storm. The tug was not damaged and stayed on the blocks in the dock. To the right of the dock is shown the excursion steamer *Apollo,* which was torn loose from her moorings at the foot of Dauphin street, 1½ miles away, without much damage to her hull. Between the dock and the steamer *Apollo* lies the pilot boat *Wayfarer,* which was also blown from her moorings at the yard of the Ollinger & Bruce Dry Dock Company. This vessel suffered slight damage to her rigging and hull.

The wreckage in the foreground of the photograph, shown in Fig. 2, is part of the pipe line and pontoons of the United States Government dredges that were at work in the harbor.

Two Russian ships, the *Frieda* and *Grace Harward,* were blown on the docks of the Texas Oil Company during the storm. The position of these vessels is shown in Fig. 3. The wreckage at the left of the Russian ships is what remains of the river towboat *Martha Hennen.*

Another vessel that was blown from her moorings at the yard of the Ollinger & Bruce Dry Dock Company is shown in Fig. 4. This is the United States snag boat *William J. Twinning,* and she was stranded on top of the wharf of the M. & O. Railroad Company. Another river boat, the excursion steamer *Charles E. Cessna,* met a similar fate. This boat, however, was stranded on the wharf of the L. & N. Railroad at the foot of Theatre street, as shown in Fig. 5.

Oil Tank Steamer Antwerpen

Description of Bulk Oil Carrier of 11,500 Tons Deadweight Capacity Built at Newport News

THE building of bulk oil carriers, which started in this country about thirty years ago, has grown to be of such magnitude that it constitutes more than half of the merchant shipbuilding of the Coast shipyards.

The first tanker built by the Newport News Shipbuilding and Dry Dock Company, Newport News, Va., was completed in 1906, and had a deadweight carrying capacity of about seven thousand tons. Eleven tankers have been built since by that company, exclusive of barges and vessels converted into tankers, the latest of which was the *Antwerpen,* recently sunk on her maiden voyage. The company has seven tankers under contract for delivery within the next two years.

Principal Dimensions

The *Antwerpen* was 474 feet 7 inches long over all, 60 feet beam and 36 feet 2 inches deep to shelter deck, with a deadweight carrying capacity of over eleven thousand five hundred tons, at a draft of about 26 feet 2 inches, corresponding to Lloyds summer freeboard. This vessel was not the largest tanker built at Newport News but was of a size which has recommended itself to the oil companies as generally serviceable. It will be noticed that its carrying capacity was about two-thirds greater than that of the tanker built ten years ago.

The particular feature in connection with the cargo oil tanks on this vessel is that the expansion trunks extend to the shelter deck in every case. This provides a larger cubic capacity and enables a full cargo of very light oil to be carried. Moreover, any fumes which may come from open hatches during the operation of filling the tanks are above the weather deck and cannot accumulate below the shelter deck. The total capacity of the main and summer tanks is over 500,000 cubic feet.

Bunker Capacity

The *Antwerpen* was built for burning either coal or liquid fuel. When burning coal the bunkers will hold over 1,400 tons, and when burning oil the bunkers will carry about 280,000 gallons, besides what can be carried in one of the cofferdams, and as many of the smaller cargo tanks as are not in use for the carriage of the cargo oil.

The vessel was fitted with quadruple expansion, reciprocating engines furnished with steam by three Scotch boilers, all located in the stern so as to be clear of the oil tanks. The oil fuel installation was in operation when the vessel cleared. A speed of about eleven knots when loaded was shown by the results of the trial trip, and the economy in fuel consumption was such as to require only about 34 gallons of fuel per knot.

The sailors and firemen were berthed under the shelter deck forward, and the engineers were berthed under the shelter deck aft, while the captain and deck officers had quarters in houses amidships. Provision was made for a crew of about 48 persons, but when operating as an oil burner a very much smaller crew is sufficient.

The *Antwerpen* was registered as an American vessel hailing from Newport News, but was transferred to the Dutch flag before leaving the builders' yard. The vessel was built with longitudinal framing, and the general arrangement is indicated on the drawings reproduced on the opposite page.

Hendricks' Commercial Register

The twenty-fifth annual edition of Hendricks' Commercial Register of the United States for Buyers and Sellers, which has just been issued, rounds out a quarter of a century of usefulness by this standard publication. The work is especially devoted to the interests of the architectural, contracting, electrical, engineering, hardware, iron, mechanical, mill, mining, quarrying, railroad, steel and kindred industries, containing about 350,000 names and addresses, with upward of 45,000 business classifications. Full lists are included of producers, manufacturers, dealers and consumers, listing all products, from the new material to the finished article, together with the concerns handling these products, from the producer to the consumer.

There are 1,512 pages of text matter and the index of contents numbers 149 pages covering over 50,000 trade references. The list of trade names, brands, titles of identification, etc., is published for the first time, and numbers 202 pages.

NEW WATERTUBE BOILERS INSTALLED ON S. S. MINNESOTA

Boilers of Heine Union Type, Built and Installed by the Union Iron Works Company, San Francisco, Cal.

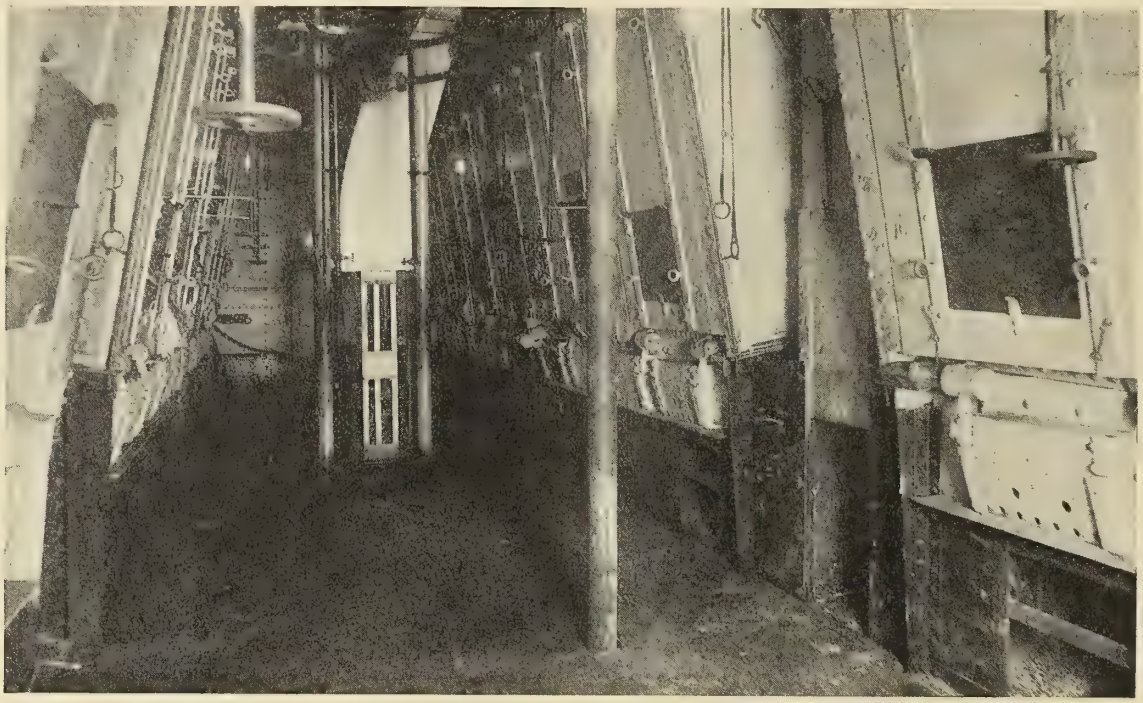


Fig. 1.—View in New Fireroom

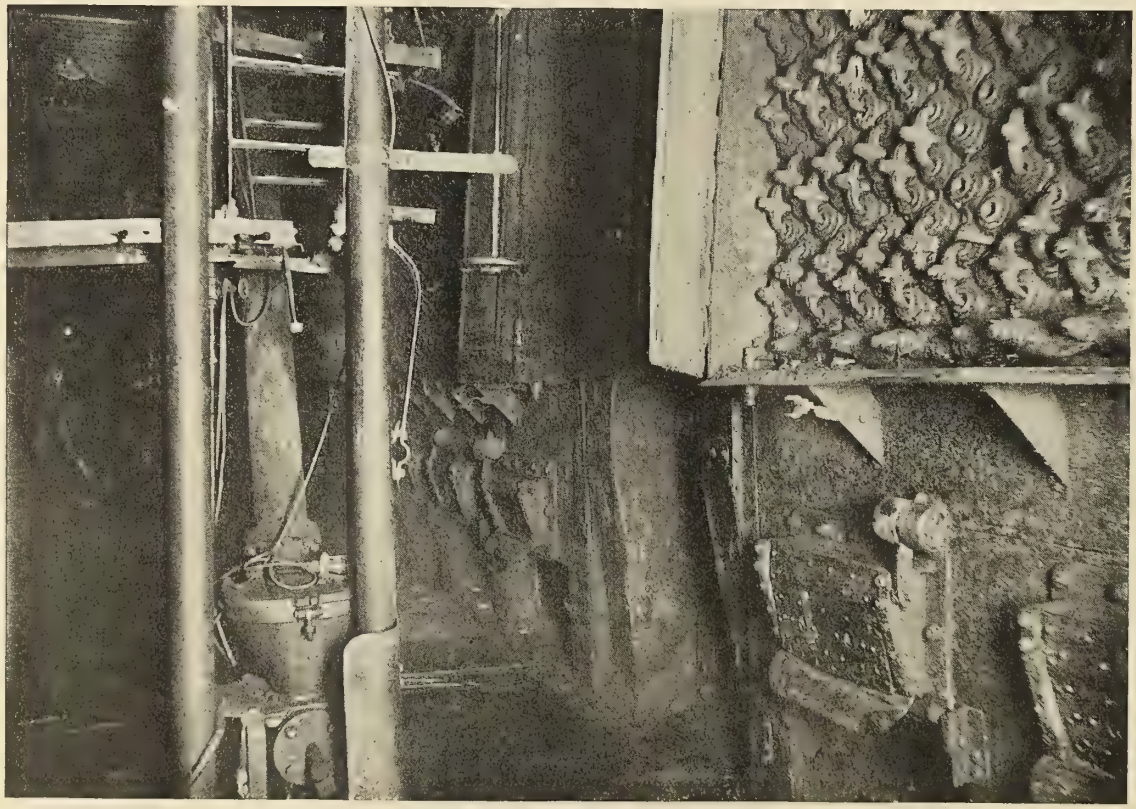


Fig. 2.—View in Old Fireroom



Fig. 3.—S. S. *Minnesota* Alongside Wharf to Receive Finishing Touches After Reboilering

S. S. Minnesota Fitted With New Boilers

Sixteen Union Heine Watertube Boilers, Total Heating Surface 43,500 Square Feet, Working Pressure 250 Pounds. Installed in Record Time

THE steamship *Minnesota* left Seattle on a voyage to Europe with a general cargo in December, 1915. When off the coast of lower California her boilers became in such bad condition that she was forced to return, arriving at San Francisco on December 14.

After several surveys and examinations it was finally decided to remove the old and install new boilers. The contract was awarded to the Union Iron Works Company to build and install complete and ready for sea sixteen Union Heine boilers. The contract was signed in January, 1916, with the understanding that the work would be completed on November 1, 1916.



Fig. 4.—New Boilers Under Construction for S. S. *Minnesota*

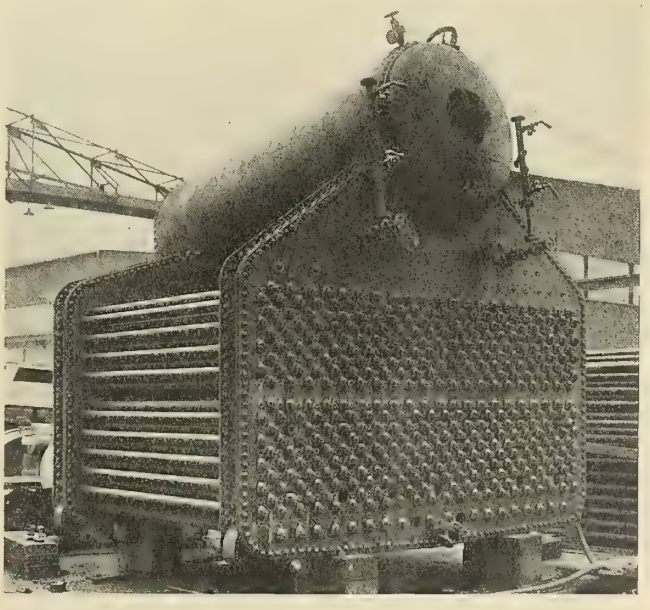


Fig. 5.—Union Heine Watertube Boiler for S. S. *Minnesota*

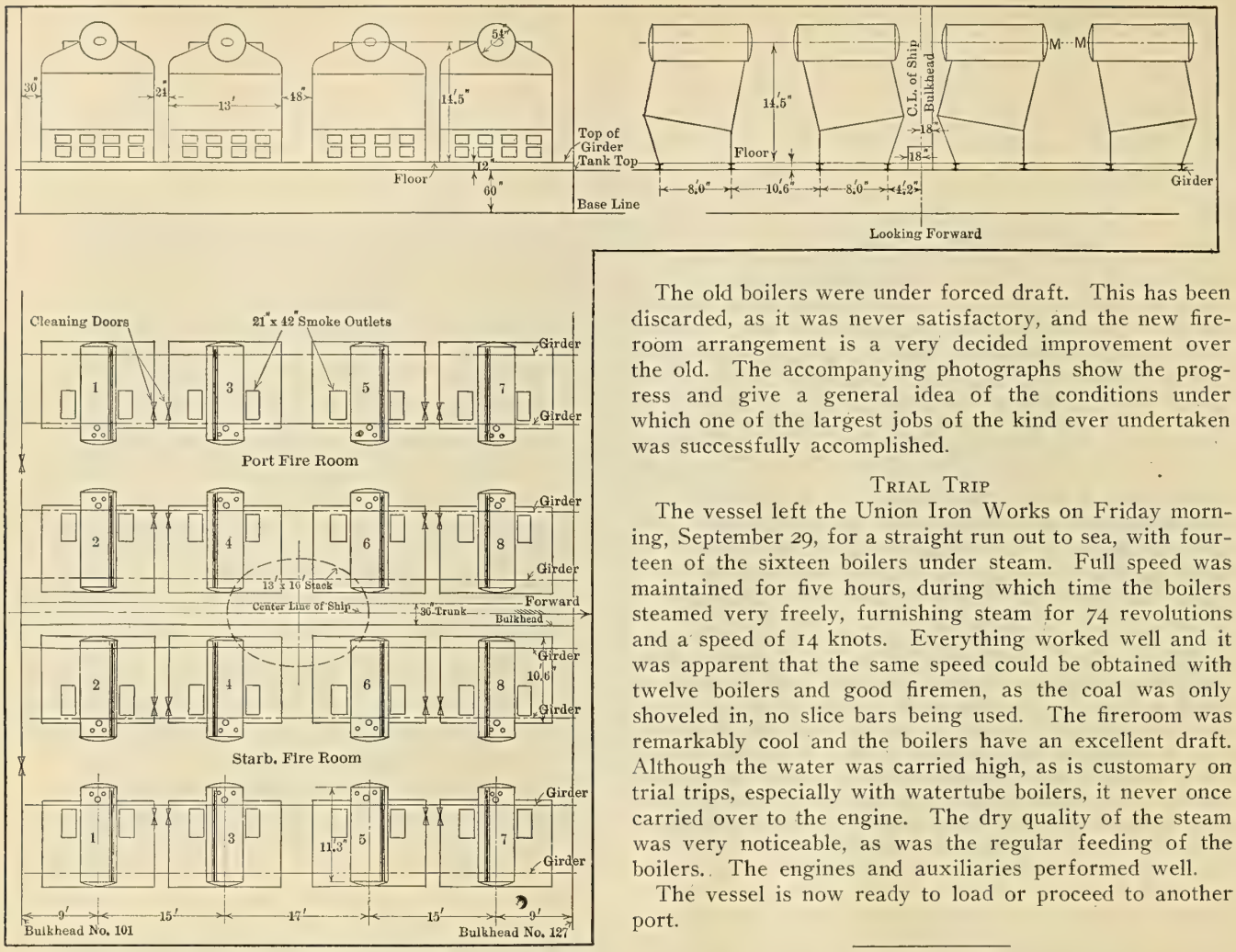


Fig. 6.—Plan, Side and End Elevation of Fireroom, S. S. *Minnesota*, Showing Arrangement of New Boilers

Considerable difficulty was experienced in obtaining material and the design of the boilers was somewhat modified on this account. The first material arrived in the yard on March 17. The crowded conditions of the shops at the yard necessitated carrying out the major portion of the work in the open. Fortunately the weather held good and the first boiler was tested on May 20 and the last was tested on July 19 and landed on the foundations in the vessel on July 20. Fires were lighted and steam raised on August 28. The boilers were tested by the United States inspectors and were under full steam and the whole installation complete on September 15.

The vessel was fully loaded, and owing to the deep draft the work was done in the bay, about 1½ miles from the works. Steam had to be kept up continuously, and for this purpose a large cylindrical boiler was placed on deck, with oil and water tanks, also dynamos and compressors. Steam was never off the vessel during this time. The smoke stack was cut off and moved to one side and all of the uptakes, etc., taken out, and the new ones installed in the same manner. A 12-ton derrick was erected on one side, which did all the lifting except the boilers, which weighed 20 tons. They were put aboard by a special boom rigged at the end of the boiler hatch.

In addition to the boilers the whole engine rooms were gutted of old and obsolete auxiliaries, piping, etc., and gratings and ladders rearranged. New feed heaters, evaporators, feed pumps, etc., and a much simpler arrangement of piping was installed.

The old boilers were under forced draft. This has been discarded, as it was never satisfactory, and the new fireroom arrangement is a very decided improvement over the old. The accompanying photographs show the progress and give a general idea of the conditions under which one of the largest jobs of the kind ever undertaken was successfully accomplished.

Trial Trip

The vessel left the Union Iron Works on Friday morning, September 29, for a straight run out to sea, with fourteen of the sixteen boilers under steam. Full speed was maintained for five hours, during which time the boilers steamed very freely, furnishing steam for 74 revolutions and a speed of 14 knots. Everything worked well and it was apparent that the same speed could be obtained with twelve boilers and good firemen, as the coal was only shoveled in, no slice bars being used. The fireroom was remarkably cool and the boilers have an excellent draft. Although the water was carried high, as is customary on trial trips, especially with watertube boilers, it never once carried over to the engine. The dry quality of the steam was very noticeable, as was the regular feeding of the boilers. The engines and auxiliaries performed well.

The vessel is now ready to load or proceed to another port.

United States Shipbuilding Reports.—The Bureau of Navigation, Department of Commerce, reports 94 sailing, steam, gas and unrigged vessels of 38,423 gross tons built in the United States and officially numbered during the month of September. Eight of these vessels, comprising 22,987 gross tons, were steel steamships. During the three months ended September 20, 337 sailing, steam, gas and unrigged vessls of 117,884 gross tons were built in the United States and officially numbered, as against 316 vessels of 46,276 gross tons for the corresponding period of 1915. There were also built during this period six vessels of 5,343 gross tons for foreign ownership.

Lloyds Shipbuilding Returns.—The returns compiled by Lloyds Register of Shipping, which only take into account vessels of 100 tons and upwards the construction of which has actually begun, show that there were 469 merchant vessels of 1,789,054 gross tons under construction in the United Kingdom at the close of the quarter ended September 30. The tonnage now under construction in the United Kingdom is about 249,000 tons more than that which was in hand at the end of the last quarter and about 253,000 tons more than the tonnage building twelve months ago.

Isherwood-Framed Ships Building in the United States.—The total number of vessels with the Isherwood system of longitudinal framing now building, or on order, in the United States is 107, with an aggregate deadweight carrying capacity of about 1,121,000 tons. These vessels comprise about 90 percent of the total oil tank tonnage and about 60 percent of the total merchant tonnage now being constructed in the United States.

Seattle's Steamship Terminals

Six Million Dollars Expended by Port Commission for New Wharves, Warehouses and Accessories

BY GILBERT C. DOHM

THE port of Seattle, situated on Elliott Bay, an arm of Puget Sound, and about 125 miles from Cape Flattery, can now boast of being one of the world's leading seaports and the greatest on the Pacific Coast. The business transacted over its wharves amounts to over one million dollars daily, an amount which is outclassed by only two other ports in the United States, New York and Philadelphia.

In 1914 the total business carried on over its wharves amounted to about $154,610,000 (£31,700,000), while 1915 showed an increase of $103,183,000 (£21,200,000) over the previous year. The first seven months of 1916 have, however, established a new record, for over $227,237,000 (£46,600,000) worth of business has thus far been carried on, making an average of over a million dollars a day.

This vast increase in shipping is due to the many advantages found at this port, including the following:

The harbor is extensive, sheltered by the surrounding mountains from severe storms, deep and absolutely free of rock, reefs or other obstruction which would endanger or hinder navigation.

It is the freest port in the world from the shipowner's point of view, the cost of loading or discharging cargo being less than any of the other great ports.

It is the principal port of distribution, due to its central location, for trade with Alaska, the Orient, Siberia, British Columbia, many of the islands in the Pacific Ocean, and for our own Northern States.

On account of the extreme width of Elliott Bay (almost five miles) and the unobstructed passage into Puget Sound



Fig. 1.—Bell Street Public Terminals. One of Six Terminal Groups Built by Port Commission

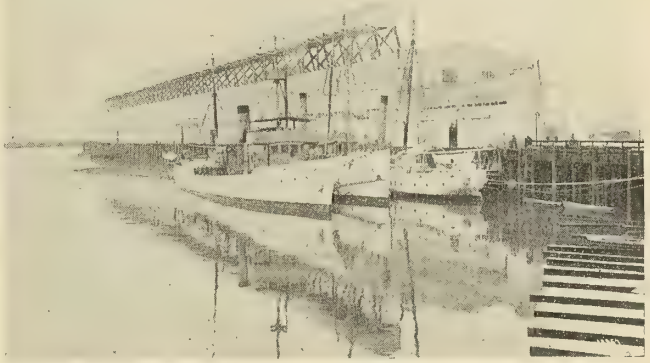


Fig. 2.—Hanford Street Wharf. 1,400 Feet of Deep-Sea Berthage. Concrete Grain Elevator (500,000 bushels capacity) in Rear

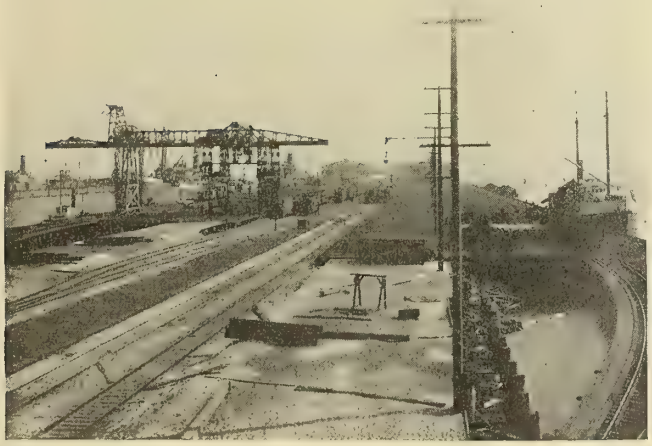


Fig. 3.—Smith's Cove Terminal. Giant Gantry and Locomotive Cranes



Fig. 4.—Stacy-Lander Slip, 800 Feet Long and 213 Feet Wide Between Fender Lines

and the Pacific Ocean, no tugboats are necessary to guide the ships to any respective channel.

There are no compulsory pilotage regulations, though all foreign steamship lines employ a pilot from Port Townsend, a distance of about forty miles from Seattle.

The vessels may shift from one part of the harbor to another under their own steam. In most other ports the aid of a tugboat is required, and an additional pilotage charge is also encumbered.

Soft coal may be obtained cheaper at Seattle than any other Pacific Coast port, but the cost of fuel oil is slightly in excess to some of the ports along this coast.

The cost of fresh water is very low, being $0.80 (3/4) for the first 1000 cubic feet and gradually decreasing in cost per 1000 feet as the quantity increases.

There are no charges for docking at any of Seattle's wharves, and the charges for vessels moored at any one of the eight steel mooring buoys in the bay is nominal being $5.00 (1/0/10) for the first three days and $2.00 (8/10) for each successive day thereafter.

The city itself is entered by ten transcontinental railroads, four of which travel over their own tracks, four using the tracks of the previous mentioned, and two entering the city by steamship connection.

Open Docking Privileges Provided by Port Commission

When the city of Seattle began to show signs of great strides forward, the railroads obtained control of most of the water front property, monopolizing the greater portion of it for their own benefit. Wharves were built by them which were used for the transportation of their own business, while other wharves also under the control of the railroads were rented to private interests. At the completion of the Panama Canal, open docking privileges became a necessity to take care of the increased sea trade. It was at this time that the Port Commission of Seattle was organized. Six million dollars were appropriated for building new wharves, elevators, warehouses, refrigerators, coal bunkers, oil receptacles, etc. The work was at once started, and to-day the terminals at Smith's Cove, Bell street, Stacy-Lander street, Whatcom avenue, Hanford street, Spokane avenue, etc., stand as a monument to the forethought of the citizens of Seattle.

The terminal at Smith's Cove is the largest of these public terminals and the largest wharf on the Pacific Coast, being one-half mile long. It is equipped with gantry cranes, locomotive cranes of fifteen tons capacity, a derrick of one hundred tons capacity and over three miles of railroad track. It is used as a general merchandise terminal in the handling of lumber and heavy cargo, and has a storage capacity of over 3,000,000 feet of lumber.

The Bell Street Terminal is centrally located, and is used for general shipping purposes, being connected to the main railroad lines by five spurs of track. Upon the roof are recreation gardens and a marine observatory.

The other terminals are all of a nature suitable for the shipment of general merchandise and the storage of fish, fruit, canned goods, etc.

Aside from the terminals a large public grain elevator has a capacity of 500,000 bushels, with a shipping capacity of 20,000 bushels per hour. The machinery is all electrically driven and of the most modern type.

All of the Port Commision wharves and warehouses are of concrete fireproof construction.

Beside the Port Commission terminals there are thirty-one other wharves owned and operated by private interests, four coal bunkers with a capacity of 15,500 tons, two oil docks with a capacity of 187,500 barrels and grain elevators with a total capacity of over 4,500,000 bushels, four floating dry docks with a total lifting capacity of 22,900 tons, and another large one in the course of construction, and two dry docks at the Puget Sound Navy Yard, about fifteen miles away.

At present there are sixty-four water lines sailing from Seattle, forty-four of these being steam lines, and with the present outlook of the shipping and shipbuilding industry the promise of more is close at hand.

Program of Naval Architects' Meeting

The twenty-fourth general meeting of the Society of Naval Architects and Marine Engineers will be held in the Engineering Societies Building, New York, on Thursday and Friday, November 16 and 17. The meeting will begin at 10 A. M. each day.

There will be a banquet in the grand ball room of the Waldorf-Astoria hotel at 7 P. M., Friday, November 17.

The following list of papers will be presented at the meetings:

THURSDAY, NOVEMBER 16

1. "New Method of Indicating the Density of Smoke as Installed on the U. S. S. *Conynham*." By Rear Admiral R. T. Hall, U. S. N.
2. "Salvage Equipment Used in Raising Submarine F-4." By Naval Constructor J. A. Furer, U. S. N.
3. "The Design of an Oil Engine." By John F. Wenthworth.
4. "Aeronautics in Relation to Naval Architecture." By Naval Constructor H. C. Richardson, U. S. N.
5. "The Power Forging of Chain Cables." By Naval Constructor F. G. Coburn, U. S. N.
6. "Description and Trials of the Turbine Steam Yacht *Winchester*." By E. A. Stevens, Jr.
7. "Theory of Fluid Friction." By W. Gatewood.
8. "Notes from Model Basin." By Naval Constructor Wm. McEntee, U. S. N.

FRIDAY, NOVEMBER 17

9. "Military and Technical Considerations of Battleship Design." By Naval Constructor R. D. Gatewood, U. S. N.
10. "On the Suitability of Current Designs of Submarines to the Needs of the U. S. Navy." By Captain W. L. Rodgers, U. S. N.
11. "Naval Stations and Naval Bases." By Captain A. P. Niblack, U. S. N.
12. "Refrigeration and Refrigerator Insulation on Board Ship." By Robert F. Massa.
13. "The Resistance of Various Types of Barges in Shallow and Deep Water." By Professor H. C. Sadler.
14. "Feathering Paddle Wheels." By Professor E. M. Bragg.
15. "Alquist Gearing for Ship Propulsion." By W. L. R. Emmet.
16. "Electric Pumping Equipment and Notes of Interest on the Union Oil Company's Tanker *La Brea*." By H. P. Frear.

Burning of Big Pacific Coastwise Passenger Steamship Congress

On September 14 the Pacific Coast Steamship Company's liner *Congress* caught fire off the Oregon Coast and was nearly destroyed. The fire started at about 3 P. M. and soon completely enveloped the after part of the ship. As soon as the fire was noticed, Captain Cousins turned his ship toward Coos Bay, which was safely reached. Here all of the passengers and crew, comprising 428 persons, were transferred without a single mishap or loss of life to the government dredge *Col. P. S. Michie*, which caught up the S. O. S. signal of distress and hurried to the assistance of the ill-fated ship.

After the the fire the *Congress* was towed to port, where temporary repairs were made on her machinery, after which she proceeded to Seattle under her own power. She was built at the New York Shipbuilding Company's plant in 1913 and was the largest Pacific coastwise liner.

BURNING OF S. S. CONGRESS



Fig. 1.—S. S. *Congress* Gutted by Fire



Fig. 2.—Rescue Ships Summoned to Burning Vessel by Wireless

BURNING OF S. S. CONGRESS



Fig. 3.—Burned Hull of S. S. *Congress* Anchored in Coos Bay

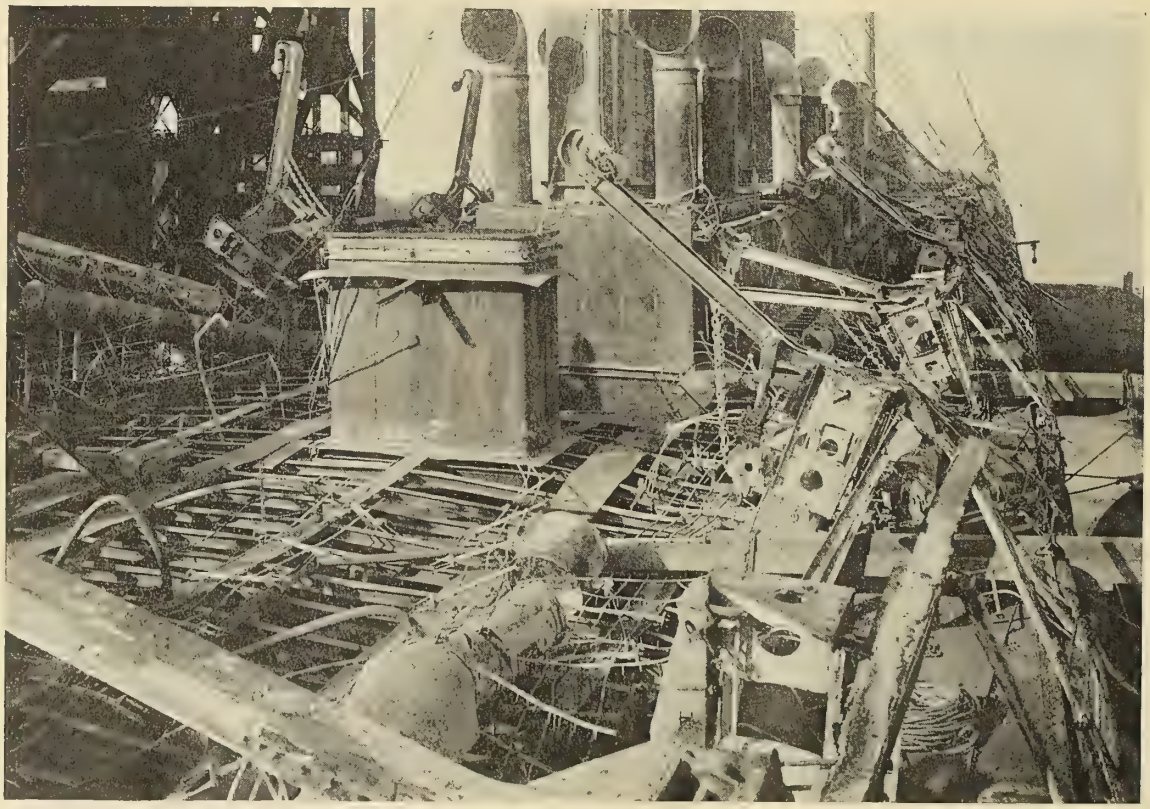


Fig. 4.—View on Decks of Burned Vessel, Showing Ruins of Upperworks

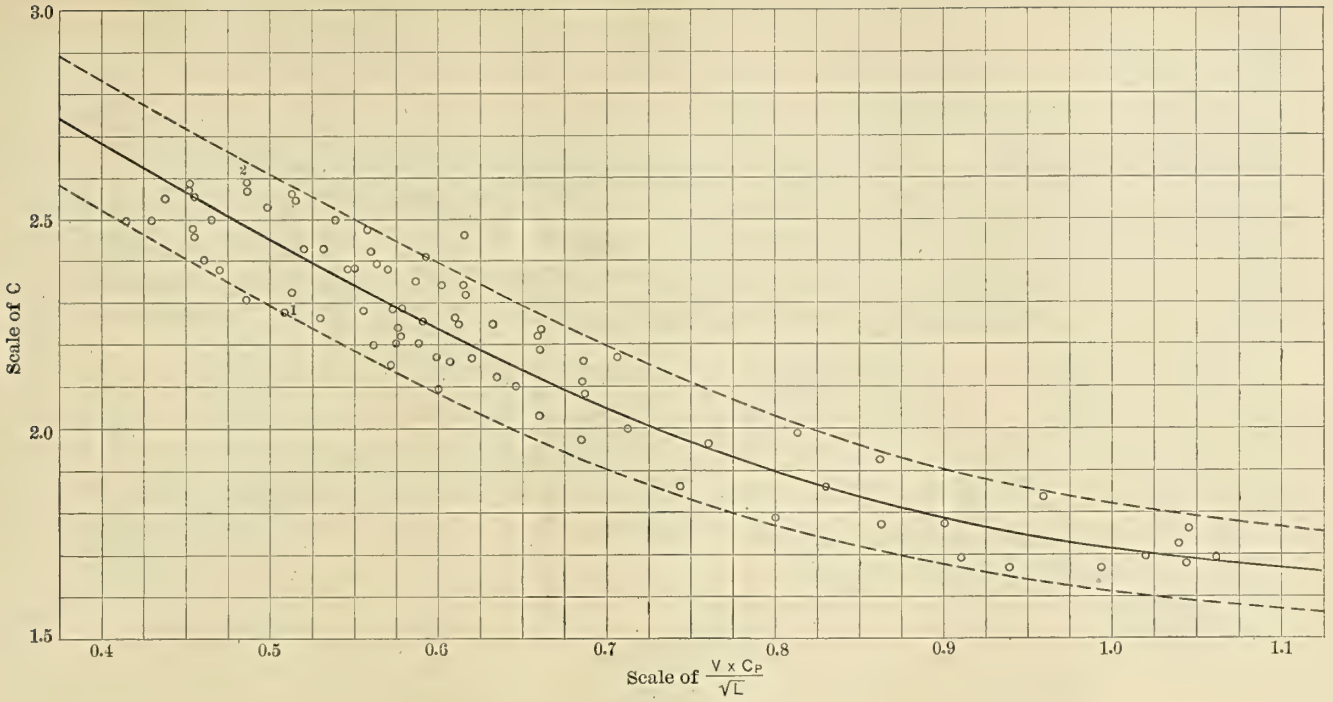


Chart I.—Curve of C Values

Power Estimating

Formula and Curves Derived as Substitute for Admiralty Method of Estimating Power

BY L. A. BAIER, B.SC.*

ONE of the most interesting phases of ship design is that practically every new vessel is a different problem in itself and is designed and built to fulfill the particular requirements imposed by the character of its cargo, run, service, terminal loading and unloading facilities, etc.

In the majority of cases the owners require a vessel to carry a certain cargo of approximately such and such a deadweight. If the depth of water in one of the ports of call is limited, this fixes at once the approximate draft for the proposed vessel, as it is usually most economical to

* Junior member Society of Naval Architects and Marine Engineers.

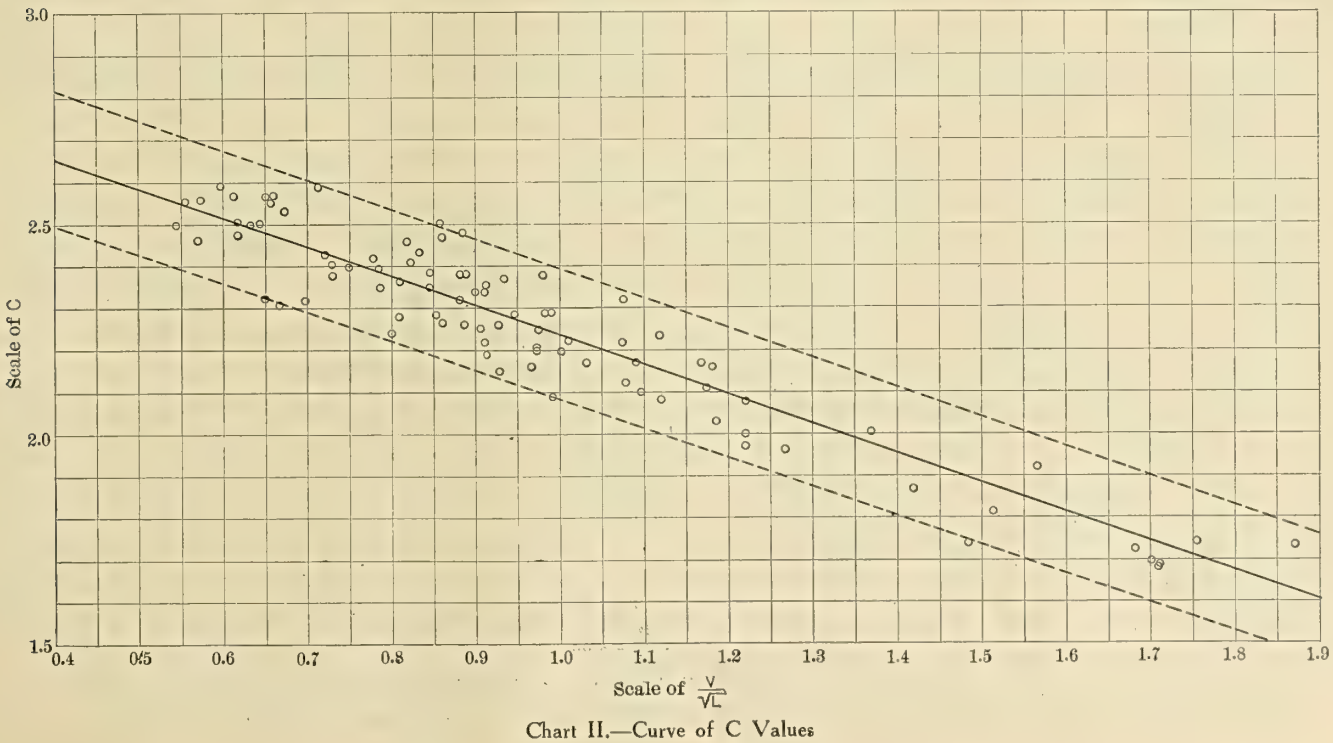


Chart II.—Curve of C Values

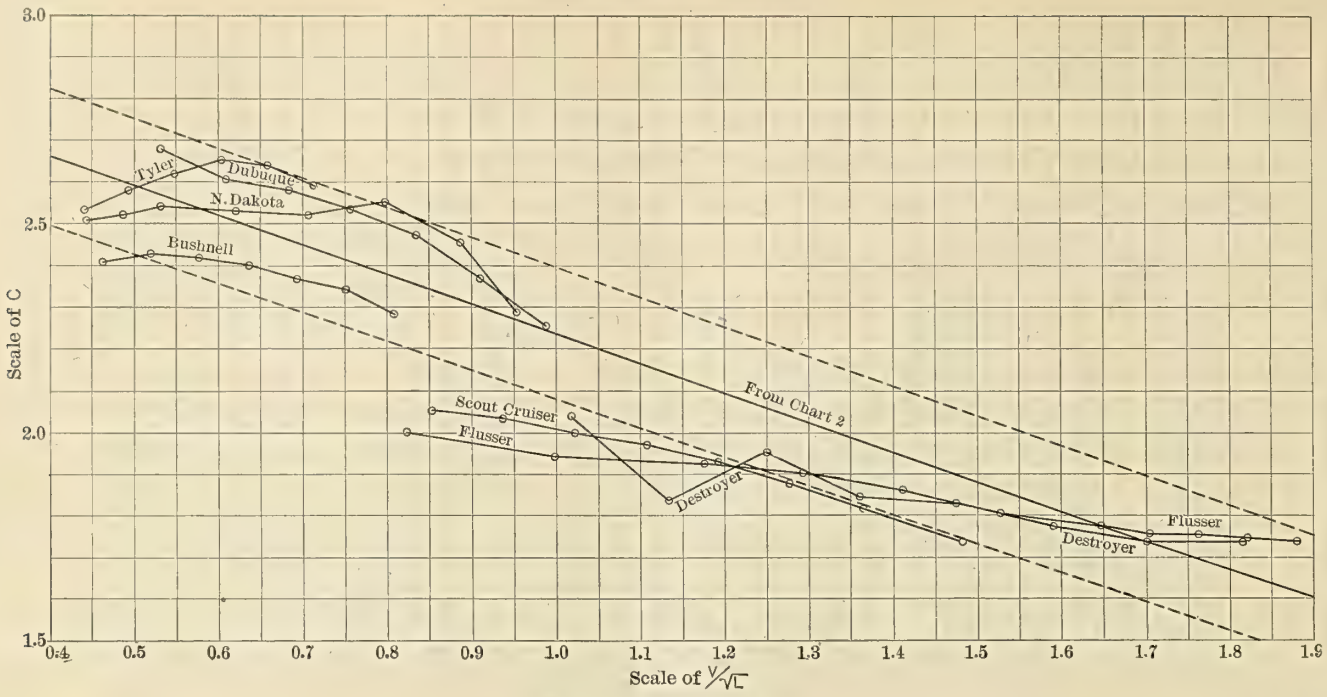


Chart III.—Progressive Trials

$C = \frac{V}{\sqrt[3]{\frac{I.H.P. \times L}{\Delta}}}$, where V = speed in knots; Δ displacement in tons, $S.W.$; L = length on load $W.L.$ For turbines $I.H.P. = \frac{S.H.P.}{0.92}$ for geared drive, and $\frac{S.H.P.}{0.97}$ for direct drive.

utilize the maximum draft allowable. The beam is largely determined by stability considerations. The character of the cargo and tentative dimensions of the vessel will determine the most economical service speed.

The service and run will usually determine the type of vessel to carry the maximum deadweight on the minimum displacement, and to realize the maximum cubic cargo capacity on the minimum tonnage rating. The vessel is usually built to the highest classification of one of the societies and must satisfy the freeboard rules, navigation laws and rulings of the Government inspection bureaus, etc.

The displacement of any vessel is, of course, equal to the total weight of the vessel and all it carries. The weights going to make up the displacement are as follows:

The weight of the hull complete comprises the steel in the hull, paint and cement, carpenter work, joiner work, hull fittings, hull engineering, equipment and outfit. Adding to this the weights of the steam engineering or machinery and ordnance gives the displacement of the vessel light. The total deadweight carried by the vessel includes the fuel, crew and effects, reserve feed water, fresh water, stores and provisions, and adding these weights to the displacement of the vessel light gives the displacement of the vessel ready for sea. Finally, the total displacement of the vessel loaded is obtained by adding to the above the weights of the passengers and baggage, cargo and ammunition.

The total displacement may be expressed by the result of a factor C_d times the total deadweight in tons. This factor will run from 1.39 in the case of certain cargo types to 4.5 in the case of passenger vessels. The de-

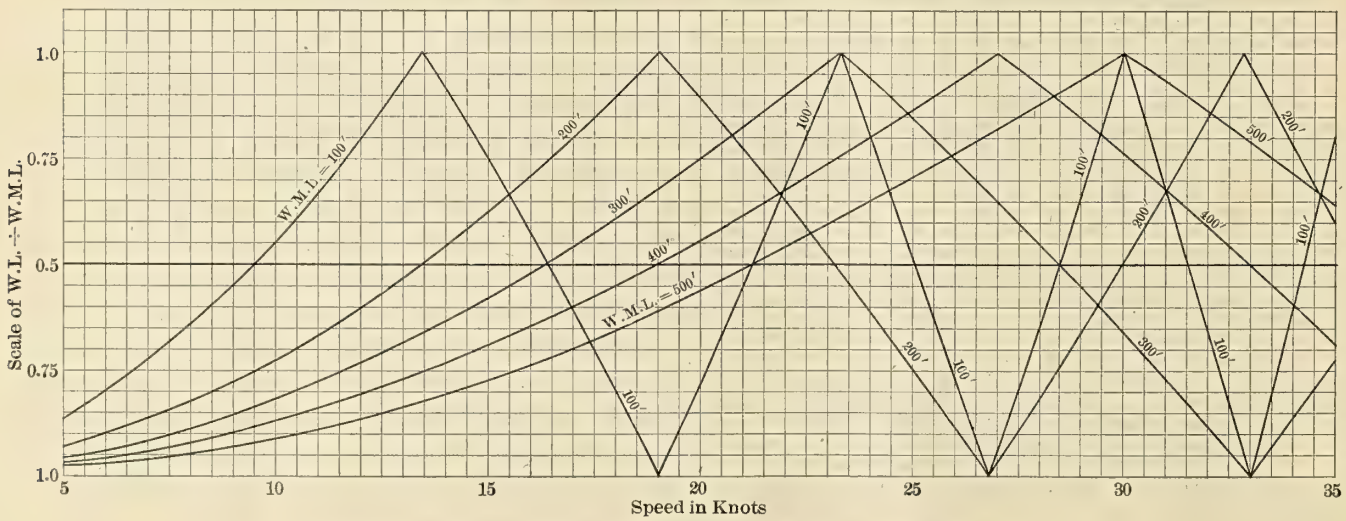


Chart IV.—Curve of Ratio of Wave Length by Wave-Making Length

Wave length $= \frac{V^2}{1.8}$. Wave-making length = 1.05 to 1.15 × L. L = Length on load $W.L.$

signer's problem, then, is to determine the combination of dimensions and form characteristics that, consistent with economy of operation and construction, stability, etc., will bring this factor C_d as low as possible.

The weight items from the foregoing table, of Steam Engineering, Fuel and Reserve Feed water, are dependent on the power involved. Hence it is necessary to know approximately in the early stages of design what power will be required for any tentative set of dimensions and displacement. The "Admiralty Coefficient," which is most commonly used, has not proven a very satisfactory one. The formula is as follows:

$$I.H.P. = \frac{\Delta^{2/3} \times V^3}{C}$$

where Δ = the displacement in tons,
V = the speed in knots,
C = a coefficient.

To obtain correct estimates of power by this method the designer must have at hand data for almost identically similar vessels. If one of the two important factors in this formula, namely, the displacement ratio, and the speed ratio varies even slightly from that of the type vessel, the admiralty coefficient will vary considerably. Again, the factor of length which has a large influence on the power is not taken into account.

The following formula and curves have been derived to give a method of estimating power in which the designer may choose the proper coefficient with less degree of error and with proper allowance for the important factors which influence the power required:

$$I.H.P. = \frac{V^3 \times \Delta}{C^3 \times L}$$

where V = speed in knots,
Δ = displacement in tons, s. w.,
L = length on waterline in feet,
C = coefficient.

For turbine installations

$$I.H.P. = \frac{S.H.P.}{0.92} \text{ for geared drive,}$$

$$I.H.P. = \frac{S.H.P.}{0.97} \text{ for direct drive.}$$

Chart I shows values of C, calculated from the trial results of some eighty vessels ranging from seagoing dredges, cargo steamers, high-speed passenger liners, to torpedo boat destroyers, plotted on a base of

$$\frac{V \times C_p}{\sqrt{L}}$$

where C_p = the prismatic coefficient.

Chart II shows values of C plotted on a base of $\frac{V}{\sqrt{L}}$ for use when the prismatic coefficient C_p is not at hand.

As shown, the values of C are found to fall within a well-defined area inclosed by the dotted curves. The full line curve represents the average values of C.

For any given abscissa C will vary above or below the average curve according to the following factors, however, practically always being found within the defined limits shown.

1. Ratio of beam over draft.
2. Propulsive coefficient.
3. Ratio of wave length over wave making length.
4. Prismatic coefficient.

If for a proposed design the ratio of beam over draft is comparatively large, say, the propulsive coefficient to be expected rather low; the ratio of wave length over wave making length, say one; and the prismatic coefficient large for this type of vessel, we would find the value of C near the lower limits of the curves. Conversely, if any of these factors is such as to favor a low resistance, C will become larger, until, if all the factors are favorable to easy driving, C will be at the upper limits of the curves. This is illustrated by points two and one on Chart I, showing the values of C for two vessels, one easy to drive and the other of large resistance for its type.

	Vessel No. 1	Vessel No. 2
Length, feet	300	331
Beam, feet	45.5	47
Draft, feet	15	16.92
Displacement, tons	3,548	4,875
Prismatic coefficient	0.629	0.682
Speed, knots	14	13
Indicated horsepower	2,740	1,870
$\frac{V \times C_p}{\sqrt{L}}$	0.508	0.487
C	2.28	2.59
Ratio beam over draft	3.03	2.78
Propulsive coefficient	0.497	0.636
Ratio wave length over wave-making length	0.67	0.73

The lines of vessel No. 2 were designed with a great deal of care, and this, combined with a very efficient propeller, resulted in a vessel remarkably easy to drive, as shown by the high value of C. In the above comparison the ratio of beam over draft, and the propulsive coefficient had the most influence in varying the values of C. For higher values of

$$\frac{V \times C_p}{\sqrt{L}}$$

the effect of differences in the ratio of wave length over wave making length becomes more important.

Chart III shows variations of C for various vessels over their progressive trials, C being plotted on a base of $V/\sqrt{L}$.

Chart IV gives curves of wave length over wave making length plotted on a base of speed V. The value of 0.5, of course, represents the most favorable ratio for ease of propulsion.

The writer hopes that the foregoing method may prove of value to those interested in obtaining fairly close estimates of power for design purposes.

Twin Screw Motor Ship Peru

The twin-screw motor ship *Peru*, built for the East Asiatic Company, recently ran her trials in the Copenhagen Sound, developing an average speed over the measured mile of 12.74 knots at 3,685 indicated horsepower and 139.3 revolutions per minute. During a four-hour consumption test the consumption of fuel oil proved to be 144.8 grammes per indicated horsepower, including the fuel oil for auxiliary motors. The fuel was Borneo crude oil of a heating value of 18,000 British thermal units.

The *Peru* is the twentieth motor ship launched from the yards of Burmeister & Wain, Copenhagen, and is of the following dimensions: Length between perpendiculars, 425 feet; beam, 55 feet; depth, 30 feet 6 inches; draft, 26 feet 5 inches; deadweight carrying capacity, 9,500 tons. She is fitted with two six-cylinder main engines developing a total of 3,100 indicated horsepower at 125 revolutions per minute designed to give the ship a speed of 11.15 knots. The vessel is further equipped with three two-cylinder auxiliary Diesel engines, each developing 90 brake horsepower at 300 revolutions per minute directly coupled to dynamos supplying current for operating of all the auxiliary machinery. In the engine room a donkey boiler furnishes steam for heating purposes and for driving a steam-driven auxiliary air compressor.



Fig. 1.—S. S. *Wyandotte.* Unloading Capacity 600 Tons per Hour

The Use of Conveying Machinery for Handling Bulk Freight on Board Ship

Lake Bulk Freighters Equipped with Self-Unloading Machinery—Self-Unloading Barges and Fuel Lighters—Conveying Machinery Electrically Driven

BY W. B. GREENE *

A NUMBER of the stone-crushing plants along the Great Lakes find their readiest market in nearby lake towns which are not equipped with special unloading docks. In delivering to these towns by ordinary freighters it is found that the vessel is tied up at the docks for a greater time than is used in actual transportation. This situation has been nicely met in a number of cases by equipping vessels with self-unloading machinery with unloading capacity equal to the average "fast" plant. The economic importance of this equipment is particularly apparent where the vessel is operating between nearby points, when the percentage of idle time due to the loading and unloading operation is very high.

The first of the vessels so equipped was the *Wyandotte,* a 310-foot vessel with a cargo capacity of 3,300 tons and an unloading capacity of 600 tons per hour. This was followed by a somewhat larger boat, the *Alpena,* built for the same owners. This vessel is 370 feet long overall, with 5,700 tons carrying capacity and an unloading capacity of 750 tons per hour. A third boat, the *Calcite,* 436 feet long, carries 8,300 tons, which it discharges by means of its own power and equipment at the rate of 900 tons per hour.

The general arrangement of the three boats is the same. Cargo is carried in a double row of hoppers provided with bottom gates and covered with wide hatchways separated by narrow deck strips. Beneath each row of hoppers is a 36-inch by 188-foot pan conveyor operating horizontally except for a slight incline at the head end. These discharge near the bow of the vessel onto a single inclined belt conveyor, 42 inches by 100 feet, rising on an incline toward the stern to a point above the deck. A fourth conveyor, 42-inch belt by 80-foot centers, is carried on a steel struss revolving boom, permitting the load to be discharged to either side of the vessel. One 90 horsepower motor drives the two pan conveyors and the inclined belt conveyor. The boom conveyor is operated by a 35 horsepower motor and the boom itself is swung by means of a donkey engine through a rope attached to the head of the boom.

The same arrangement obtains on the *Alpena,* on a somewhat larger scale, but with better space economy by the substitution of a heavy inclined bucket elevator for the intermediate belt conveyor. The conveying systems consist of two 36-inch by 264-foot steel pan conveyors discharging to a 54-inch by 60-foot bucket elevator, this in turn discharging to a 36-inch by 77-foot belt conveyor on the revolving boom.

The *Calcite* adopted the mechanical arrangement of the *Alpena* in substantial details on a still larger scale. The gathering conveyors are of the pan type, 42 inches by 310 feet. The incline bucket elevator is 72 inches by 67 feet and the boom belt conveyor is 48 inches by 90 feet.

This same idea has also been profitably applied on a smaller scale to several barges. These may or may not be propelled under their own power. The 1,200-ton barge *Adriatic,* on the Great Lakes, has a double row of hoppers and a system of conveyors and elevators similar to those used on the larger vessels described. This barge carries a 55-foot boom conveyor and discharges at the rate of 120 tons per hour. The San Pablo Quarry Company barge *No.* 1, operating on the Pacific Coast, carries a single row of hoppers and the unloading equipment consists of a belt conveyor delivering to an elevator carried on a revolving base.

Usually where barges are thus equipped they are owned and operated by the producing company. In the case of the larger vessels they have been built by transportation companies, although usually to serve a definite established trade or business which frequently controls the transportation company.

* Engineer, Stephens-Adamson Manufacturing Company, Aurora, Ill.

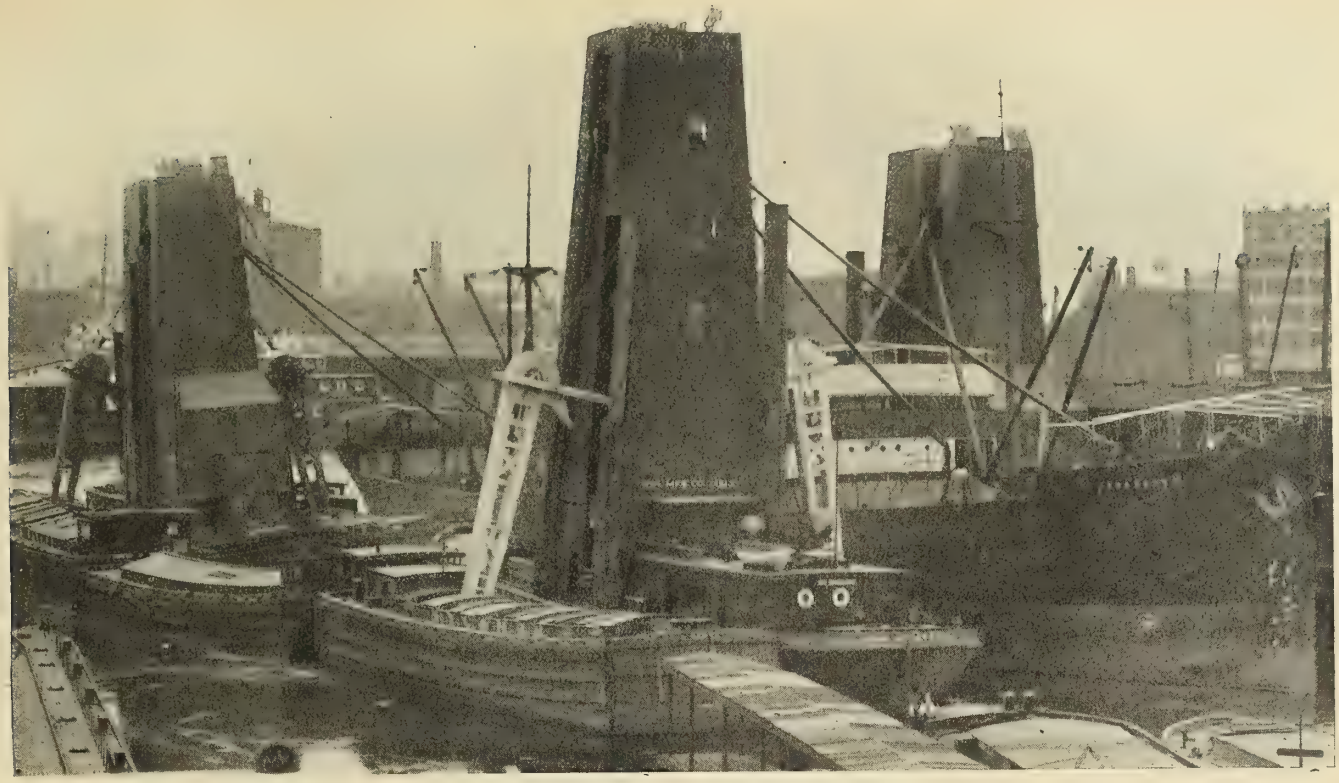


Fig. 2.—Floating Grain Transfer Elevators

Self-Unloading Fuel Lighters

Another important adaptation of self-unloading equipment is found in modern fuel lighters. The supply of fuel to steamers usually involves loss of valuable time as the ship must go from the unloading point to the coaling point and tie up to receive fuel. In many cases coal is delivered by lighters, simultaneously with unloading the freight, the coal being handled by wheelbarrows or by derricks and grab buckets; even in these cases it is rarely practicable to deliver a full supply of fuel while the steamer is discharging its cargo.

The *West Shore* lighter of the Pickands-Mather Company, which is equipped with self-loading machinery, was put into service for fueling that company's own ore boats as well as others using that harbor. This lighter is 170 feet long by 36 feet beam, with a hopper capacity of 1,000 tons. The unloading machinery has a capacity of 500 tons per hour, and as the large ore steamer takes only 250

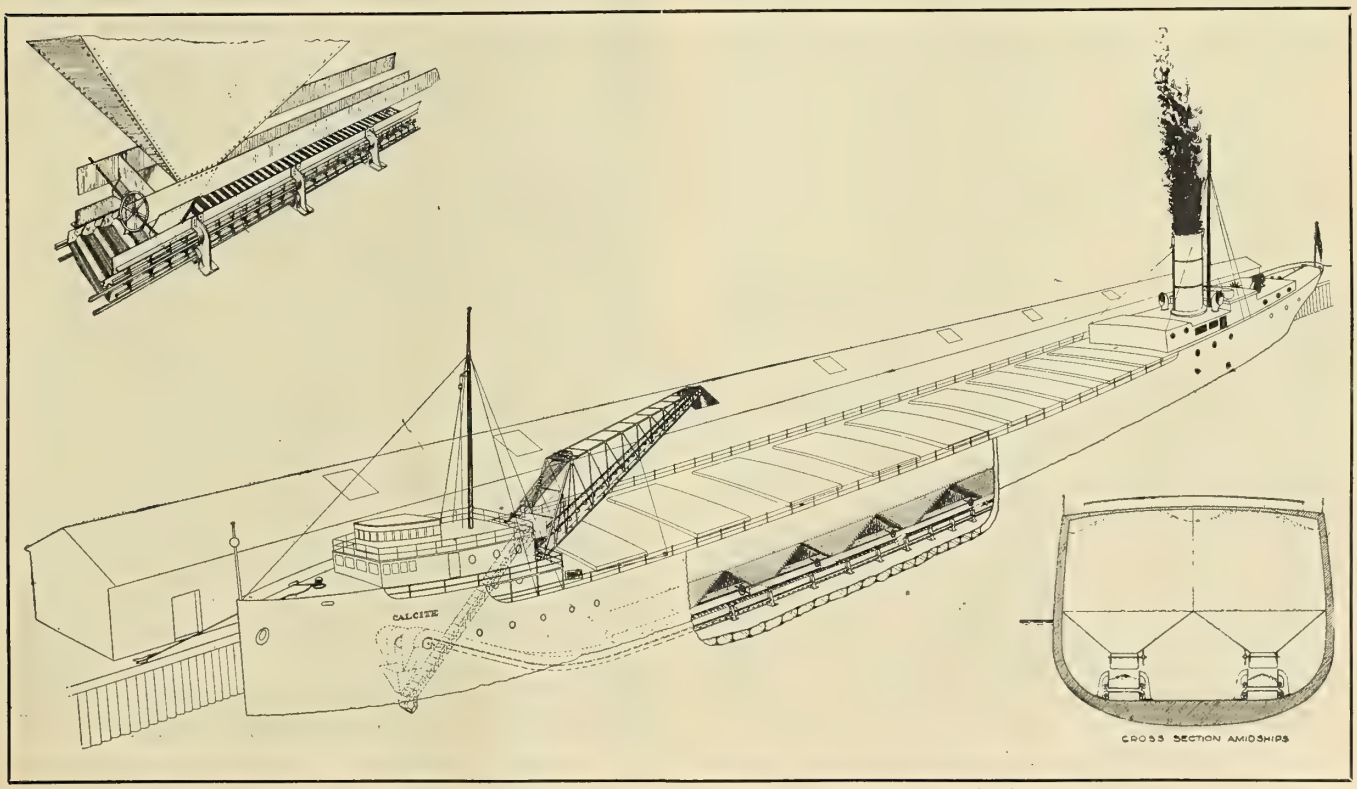


Fig. 3.—General Arrangement and Type of Conveyors Used on S. S. *Calcite*

to 300 tons of coal at a time, it can be supplied very quickly and may deliver coal, even with the steamer in motion. The unloading equipment consists of twenty-two reciprocating feeders delivering to two 42-inch steel pan conveyors, 57 feet long, placed tandem, these delivering centrally to a 48-inch by 30-inch vertical bucket elevator. This in turn discharges to a 42-inch steel pan conveyor, carried on a 50-foot revolving boom. The loading station which serves the *West Shore* is equipped with a 48-inch by 170-foot steel pan conveyor, with a capacity of 500 tons per hour. The conveyor extends under three track hoppers and the discharge end is pivoted to raise and lower.

The vessels of the various types described in this article were all equipped with conveying machinery designed and manufactured by the Stephens-Adamson Manufacturing Company, of Aurora, Ill. Some of the barges had previously been in service without unloading equipment, although the larger vessels were designed to accommodate the special hoppers and self-unloading equipment, which was installed during the construction of the vessel.

Thor Pneumatic Tools in Shipyards and Dry Docks

While pneumatic tools have been used in shipbuilding and dry dock work since they were first introduced, the importance of these small portable machines was never so fully realized as since the recent activity in the shipbuilding industry in this country.

The unprecedented demand from shipbuilders for pneumatic tools for various kinds of work resulted in a complete study being made by the Independent Pneumatic Tool Company, Thor Building, Chicago, Ill., of the service required and the tools best adopted thereto. This information, which is the result of numerous tests made with the Thor air tools and observations made by the company's experts, has been furnished this paper for the benefit of its readers.

It has been demonstrated that the size D-3 non-reversible piston air drill equipped with a No. 3 Morse taper socket is best suited for drilling and reaming on all bulkheads, shell clips and all close work inside of the hull. This machine is also used for all work in the intercostals, as well as for all 13/16-inch and 15/16-inch deck reaming.

The size C-4 non-reversible piston air drill equipped with a No. 4 Morse taper socket is used on all waterway bars, bulkheads, beam brackets and shell clips where closeness is not essential. This machine is also adapted for all reaming in shell work, taking the place of the heavier drills formerly used. It weighs only 40 pounds, and, like



Fig. 1.—No. D-3 Drill, Reaming 7/8-Inch Holes on Poop Deck of Ship

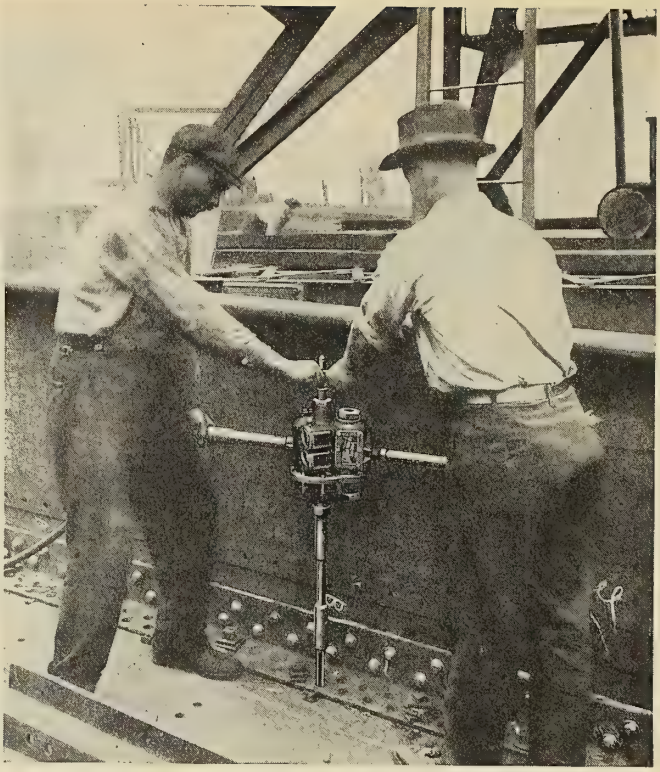


Fig. 2.—Size C-4 Thor Drill, Reaming 1-Inch Holes in Waterway Bars



Fig. 3.—Corner Drill, Reaming 7/8-Inch Holes Through Intercostals in Tight Places in Double Bottom



Fig. 4.—No. B-W Thor Drill, Boring 1½-Inch Holes in Oak Timbers for Launching Ways

size D-3 machine, is equipped with a special spindle permitting the use of oversize shanks and tangs on twist drills and reamers.

For boring out stern frame eyes and pintles, when the stern frame is in place the size "NN" compound reversible machine is used. All classes of work requiring a boring bar and flue rolling up to 5 inches in diameter in marine boilers can be performed with this motor.

The sizes E, F and G, small drills, are used by the plumbers, pipe fitters and in the sheet metal shops for all drilling and reaming bolt holes or rivet holes on flanges,

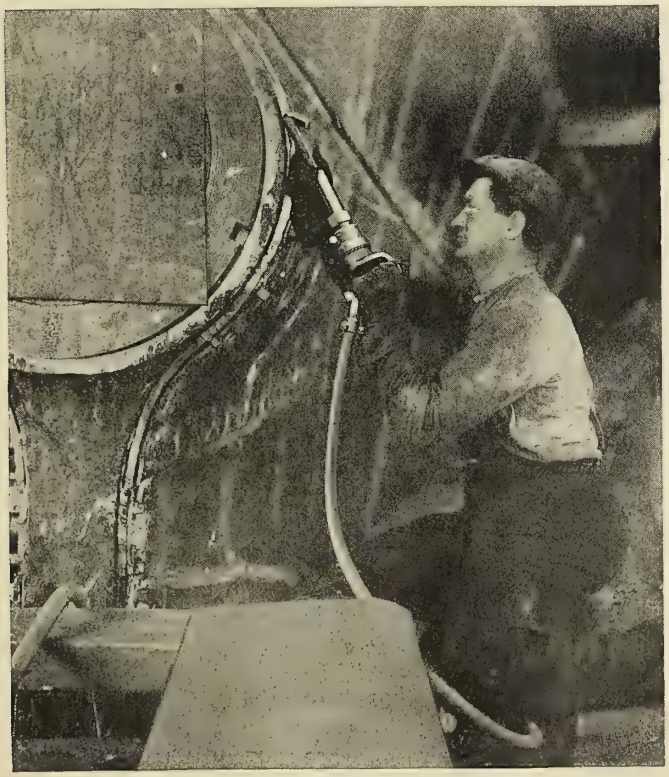


Fig. 5.—Chipping Boss Plate and Making Up Patch Bolts on Propeller Eye with Size B Chipping Hammer

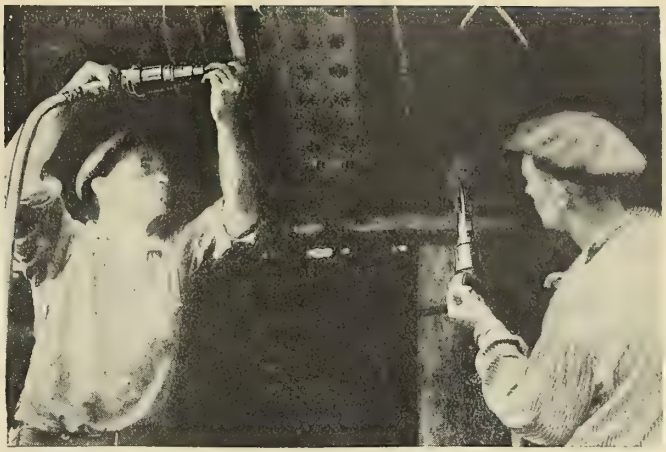


Fig. 6.—Two Size "N" Thor Tank Testing Hammers at Work

etc. These drills weigh only about 10 pounds and can be used in very close corners, and, although rated up to 9/16-inch capacity, they can be used for drilling ¾-inch and ⅞-inch diameter holes when they occur in a proximity of the work being done by the operator.

Special Machine for Close-Quarter Drilling

The No. 8 close corner drill is a very handy machine in all close-quarter drilling in water bottoms between frames, while the No. 9 is used for all kinds of close-quarter work

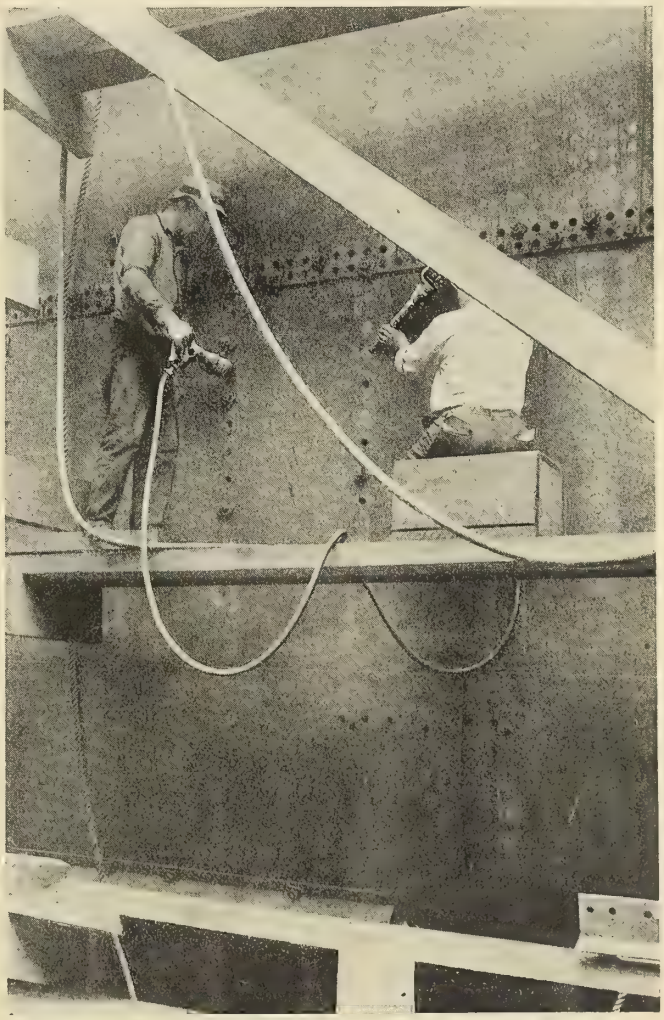


Fig. 7.—No. 60 Riveting Hammer, Driving ⅞-Inch Shell Rivets and No. B Chipping Hammer Chipping Heavy Work

in setting heavy engine frames, etc. It can also be supplied reversible for rolling the outer tier of flues where ordinary center-spindle drills cannot be operated.

In the marine boiler shops the size "BB" is used for staybolt drilling and tapping and running in staybolts and driving studs.

The size "BW" reversible wood-boring drill is adapted for all kinds of work up to boring 2-inch holes and general timbering about the stocks or launching ways or similar uses.

The No. 72 portable air grinding machine can be used with satisfactory results in surfacing all kinds of armor plates, turrets, etc., after the chipping hammer or the burner. It is also used for cleaning and squaring the

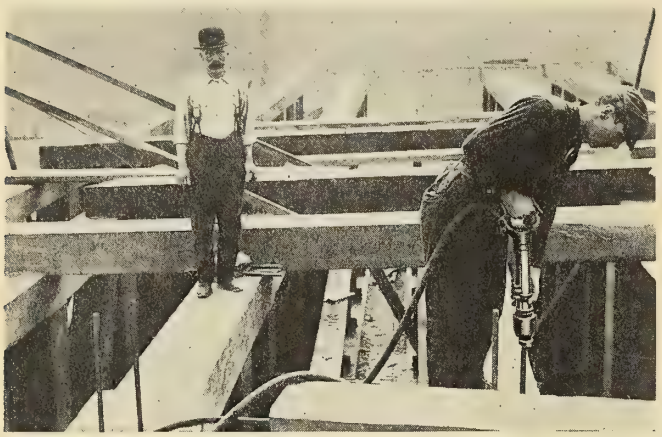


Fig. 8.—No. 90 Thor "Safety First" Riveter, Driving 3-Foot by 1 1-16-Inch Drift Bolts in Shipways

coping on channels, frames, beams, etc., after the burners are finished, and is a very convenient tool for finishing up work on all parts of the ship.

The size "B" Thor pneumatic chipping hammer is the lightest tool on the market capable of the heaviest shell calking and chipping. It weighs only 10¾ pounds and is suited to all-around cutting, scarfing and calking, while the size "NN" scaling hammer is particularly suited for tank testing work, being capable of performing the work of three hand testers.

The riveting hammers manufactured by this company are of the one-piece type, having a dropped forged barrel and handle which cannot come loose or leak air. The No. 60 equipped with an outside trigger is recommended for all classes of shell, tank-top and bulkhead driving and is considered a standard riveter for all classes of shipyard work, being light and short in length. The No. 90 with outside trigger is used in the marine boiler shop for steam-tight work. This hammer can be equipped with a "safety-first" rivet set retainer when so specified, making it particularly suited for driving drift bolts, spikes, etc., in the ways and stocks. The set retainer prevents an inexperienced operator from shooting the set out and losing same overboard.

THE NEW BATTLE CRUISERS.—Plans for the new United States battle cruisers call for vessels 850 feet in length with a displacement of 35,000 tons and a speed of 35 knots. The beam will be about 97 feet and the main battery will consist of ten 14-inch guns. The four new battleships authorized at the same time will be 624 feet long overall, 600 feet long between perpendiculars and 32,600 tons displacement. The main battery will consist of 16-inch guns.

NEW BOOKS FOR MARINE ENGINEERING

MARINE STEAM TURBINE. Fourth edition. By J. W. M. Sothern. Size, 6 by 9 inches. Pages, 555. Illustrations, 330. New York, 1916: D. Van Nostrand Company. Price, $6 net.

The development of the steam turbine during the last decade has brought more changes in modern practice of marine engineering than any other one factor. Not only is the steam turbine becoming practically the sole means adopted for propulsion of war vessels, but its application to merchant vessels is becoming widespread, especially since the application of reduction gears between the turbine and the propeller has been perfected. Bearing this in mind, no modern marine engineer can afford to ignore the turbine—in fact, he must not only be thoroughly familiar with its construction and the general principles underlying its operation, but he must be competent to take charge of a turbine plant and operate it economically. The book on steam turbines which Mr. Sothern has compiled gives a practical description of the two most common types of turbines used on board ship—the Parsons and the Curtis. It tells how these turbines are constructed, fitted and run under present practice. The text is fully illustrated with large diagrams and detailed drawings of the machines. The theory and mathematical discussion of the thermodynamic problems involved in turbine work are fully explained. The present edition of this book has been greatly enlarged, no less than ten sections, or chapters, having been added.

LAND AND MARINE DIESEL ENGINES. By Giorgio Supino. Translated by Engineer Lieutenant-Commander A. G. Brenner, R. N., and James Richardson, B. Sc. (Eng.) London. Size, 6 by 8¾ inches. Pages, 309. Illustrations, 300. Plates, 19. Philadelphia, 1916: J. B. Lippincott Company. London, 1915: Charles Griffin & Company, Ltd. Price, $3.75 net.

Comprehensive treatises on Diesel engines, especially of the marine type, are comparatively few in number, due mainly to the fact that the development of this type of engine up to date has consisted largely of experimental work, leaving the design in a state of transition, so that any discussion regarding it is apt to become almost out of date during publication of the information. Four-cycle Diesel engines, however, have already passed beyond the critical and experimental stages of their development and permit more extended treatment. Two-cycle engines of large power have not been brought to a stage of development where their commercial success is assured. Bearing these limits in mind, this book deals very exhaustively with both the thermodynamic and practical questions regarding the construction and operation of marine Diesel engines. The text is profusely illustrated with excellent detailed drawings, many of them in the form of large plates. These drawings and the formulæ will be very useful not only to the young engineer taking up practical work in oil engines, but also to experts as a book of reference. A section of the book which is of special value for reference is that dealing with the rules and classification societies for the construction of marine oil engines.

The book is divided into two parts, the first describing the general principles of Diesel engines, the fuels, thermodynamic cycles, efficiencies and the calculation of cylinder dimensions. The second part describes in detail the design and construction of various parts of commercially developed engines and accessories, and gives information regarding the tuning up and acceptance trials of the engines.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Feed Water Heating

With the advent of the triple expansion engine came its legitimate accompaniment, the high pressure boiler, and with high pressures came the necessity of heating the feed water. The temperature of saturated steam of 175 pounds pressure absolute is 370.8 degrees F., while feed water is frequently at so low a temperature as 110 degrees F. We have then a cool current of water taking a devious course through the other water of the boiler, impinging in its wanderings against hot heating surfaces, subjecting them to sudden contraction or against columns of steam bubbles on their way to the water line, effecting their condensation and perhaps inducing foaming. In fact, a current of cold feed water must be rated as one of the worst disturbing elements that a boiler has to contend with.

In shell boilers, which have neither appliances for heating the feed nor means for producing a thorough circulation, a body of comparatively cold water settles at the bottom and does considerable mischief. The general double-ended boiler attains a length of about 20 feet. In the case of such a boiler, if the temperature of the water at the bottom be 150 degrees and the temperature of the upper portion of the shell be 370 degrees F. (corresponding to steam of 160 pounds gage pressure), the difference of expansion between the two opposite parts of the shell amounts to about 0.33 inch. The strains thus set up are well known to be the cause of many leaks and fractures.

With feed water heated to live steam temperature, such strains are entirely obviated. In some cases the feed water is not heated up to the live steam temperature, the benefits of such treatment being, of course, proportionately less.

For heating feed water three methods have been tried, namely:

Class A. Arrangements of pipes or flues in uptake.

Class B. Arrangements of feed coils surrounded by exhaust steam from receivers, or live steam.

Class C. Direct commingling of the steam with the feed water without the intervention of heating surfaces.

Devices in Class A have long been in use. The chief objections to them are: liability of the heating surfaces to burn from being fouled with scale, grease or other dirt, liability to corrosion from the effects of moisture, acids in the furnace gases, and so on, and also inaccessibility for effecting repairs.

The other two forms—Classes B and C—are the ones now most commonly in use, and it is not improbable that uptake heaters will be entirely discarded, if, indeed, such is not the case at the present time.

For Class B it may be said that the arrangement of tubes acts to a certain extent as a grease extractor, the grease adhering to the tubes, from which it may be moved periodically. With the increasing employment of oil eliminators on the exhaust pipes of engines, it is not likely that the feed water will contain much, if any, oil. Should the feed water contain any scale-making constituents, the hot tubes will precipitate and receive the same, and thus save the heating surfaces of the boiler. Against this class of heater may be noted its somewhat complicated structure, its expense and more or less inconvenience of cleaning and scaling.

Those forms of heaters under Class C are, in the author's opinion, the simplest of all, just as the old jet condenser was simpler than the modern surface condenser. By heating the feed water with direct contact of steam a smaller apparatus is made effective, since there is no transmission of heat through slow conducting metals. If the heater is to be employed in the double capacity of heater and scale precipitator, then there must usually be provided a series of plates or pans to receive the precipitate, the heater being opened at intervals and the pans removed for scaling. In this case there is probably but little saving in weight over Class B. The scale pans of Class C are somewhat more convenient for removal and scaling than are the tubes of Class B, and the matter of expense is probably in favor of Class C.

Since steam is used as the heating agent in two of the classes of heaters under consideration, it becomes important to inquire whether the heating should be accomplished entirely with live steam or partly with exhaust steam and partly with live steam. We shall first assume that one pound of feed water is heated up to the live steam temperature by the employment of live steam alone. Next we shall consider one pound of feed water heated up in successive stages by steam from the low pressure receiver, steam from the intermediate pressure receiver, and finally by live steam.

1. To heat one pound feed from 110 degrees F. to 370.8 degrees F., with steam of 175 pounds absolute pressure and temperature of 370.8 degrees F.:

Number of heat units to be imparted = 260.8.

Number of heat units to be surrendered = 855.6 x = 260.8 degrees F.

Number of pounds steam condensed = x = 0.3048.

Total pounds feed sent to boilers = 1.3048.

2. (a) To heat one pound feed from 110 degrees F. to 228 degrees F., with steam from the low pressure receiver, of 20 pounds absolute pressure and temperature of 228 degrees F.:

Number of heat units to be imparted = 118.

Number of heat units to be surrendered = 954.9 x = 118.

Number of pounds of steam condensed = x = 0.1235.

Number of pounds of augmented feed water = 1.1235.

(*b*) To heat 1.1235 pounds of feed from 280 degrees F. to 302.9 degrees F., with steam from the intermediate pressure receiver of 70 pounds pressure absolute and temperature of 302.9 degrees F.:

Number of heat units to be imparted = 84.15.

Number of heat units to be surrendered = 902.9 x = 84.15.

Number of pounds of steam condensed = x = 0.0932.

Pounds of augmented feed water = 1.1235 + .0932 = 1.2167.

(*c*) To heat 1.2167 pounds of feed from 302.9 degrees F. to 370.8 degrees F. with steam from boiler of 175

pounds pressure absolute and temperature of 370.8 degrees F.:

Number of heat units to be imparted = 82.61.

Number of heat units to be surrendered = $855.6\ x = 82.61$.

Number of pounds of steam condensed = $x = .0965$.

Total feed = 1.2167 + .0965 = 1.3132 pounds.

In Case 1 one pound of steam passed successively through the high pressure, the intermediate pressure and the low pressure cylinders. In Case 2, 1.2167 pounds of steam passed through the high pressure cylinder, 1.1235 pounds of steam passed through the intermediate pressure cylinder, and one pound of steam passed through the low pressure cylinder. Since, in all properly adjusted triple expansion engines, the work is divided more or less equally among the three cylinders, we may, for the purposes of comparison, assume that one pound of steam performs the same amount of useful work in each one of the cylinders through which it may pass. Then, in case No. 1, the work would be represented by 1 + 1 + 1 = 3. In case No. 2 the work done would be represented by 1.2167 + 1.1235 + 1 = 3.3402.

Placing the above results in tabular form we have:

	Heating by Live Steam Only	Progressive Heating
Total pounds feed sent to boiler	1.3048	1.3132
Number heat units surrendered to heat feed	260.8	284.76
Number pounds steam condensed to heat feed	.3048	.3132
Comparative work done in cylinders	3.00	3.3402
Work done per pound of feed	2.299	2.543

Gain by progressive heating, 10.6 percent.

Whether the increased economy to be anticipated by the adoption of progressive heating would warrant its increased cost is an open question. As to the absolute economy of feed water heating, it is not difficult to understand why the uptake heaters effected a saving, as the heat which they utilized would otherwise have passed up the smoke pipe and been wasted. Steam feed heaters were at first employed to relieve the boiler strains consequent upon the employment of cold feed water, and the resultant economy of the practice was a surprising discovery.

THOMAS J. ROGERS.

The Allen Dense Air Ice Machine

It was with considerable interest that I read the article by F. C. W. of his troubles with the Allen dense air machine, published in the July issue. He starts in with the admission that he had no experience with this type of machine, and that for a while he let well enough alone. It seems, after reading his article, that, according to his troubles with continued breakdowns, he got plenty of experience at the expense of many new parts, and, in my opinion, he could have saved himself a great deal of trouble and the owners of the ship the expensive repairs, even without having any previous experience on this special type of machine, for, after all, the Allen machine is in a sense similar to an engine in its construction, and most of his troubles were practically engine troubles. Certainly the expander cylinder is of the same principle and the compressor cylinder is of the same construction excepting the port passages through the slide valve.

Now, while I do not want to seem to be an unfair critic of the article by F. C. W., I do want to make it clear that from my eight years' experience with all the different sizes of Allen dense air machines, from the ½-ton to the 3-ton, I have found that the valves as originally designed and installed by the makers of the machines are correct, and give excellent results. Unless the measurements are changed by some inexperienced person they never could change. The expander valve cannot change, even by excessive wear, and only by excessive wear or planing down can the face of the slide valve in the compressor valve chest change the slightest. This would mean the shortening of the distance between the exhaust port edges due to the exhaust port cavity being on a radius, thus taking a little off the face could shorten the distance as mentioned. But this is now impossible on the new valves that are now made or any spares furnished for old machines, for this exhaust cavity is milled deeper and with square depth shoulders.

F. C. W. states that a new expander cylinder was installed and that when started things did not run right, and that he traced the trouble to the expander valve. Now, a 3-ton machine has two valves on the expander cylinder, a slide valve and a cut-off valve. Although he does not state it, I take from reading the article that he added ⅝ inch to the length of the cut-off valve; this would, if it was the original valve installed by the makers, change its length from 5 3/16 inches in length to 5 13/16 inches. Now, this would be a mystery to me how the machine could operate satisfactorily with this large change in the measurements of the valve. The proper settings for the expander valve of a 3-ton machine are: lower or slide valves, lead 1/32 inch; upper or cut-off valve closes or cuts off at 6¼ inches. With these settings the valves should give proper running results in so far as the settings are concerned. Three and one-half expansion is about what should be expected.

The machine when started has to build up the pressure of five atmospheres (60 or 70 pounds) in the system before she starts working. This is then taken by the compressor cylinder and compressed to 210 or 240 pounds (a ratio of 3 to 1 being about right between pressures). This heats the air. Heat that is stored up by the labor expended upon compression is partly removed by passing it through a copper cooling coil which is immersed in circulating water, the temperature being reduced to nearly that of the water. The air then passes into the valve chest of the expander, which is in construction very much similar to the usual steam engine equipped with a cut-off valve. The valves admit the compressed air (210 or 240 pounds) upon the piston to a certain point of the stroke and then cut off. The piston continues to travel to the end of the stroke, the air exerting pressure upon it (constantly diminishing by expansion). This takes out of the air a quantity of heat equal to the labor performed by the air in expanding. The result is a very low temperature at the end of the stroke. The return stroke pushes the cold air out into the system at a pressure of 60 or 70 pounds.

The expander helps the steam cylinder and the compressor takes the power. The expander cylinder cut-off valve must cut off the pressure at such a point that the expanded air at the end of the stroke of the piston is very nearly the same as the pressure in the system out into which it pushes it. If it were of much higher pressure it would at exhausting warm up again by exerting its remaining power in producing velocities and friction inside of the apparatus.

Many troubles can be avoided in the operation of the dense air machine if they are given the proper care. A few points on their operation that will help are given here.

Do not overtax the capacity of the machine. The amount of piping used in refrigerating the storage boxes or rooms should be such as to give about one square foot of outside surface of piping to three square feet of interior room surface (ceiling, sides and floor: interior divisions not counted) for the rooms which the cold air enters first. For later rooms 2½ square feet, and when

very large amount of room is to be cooled the last room should have about one square foot of refrigerating surface for two square feet of interior room surface. It is best to have the cold air enter the room first near the ceiling, especially in the later rooms, so the air currents may ascend to near the ceiling. The rooms that are to have the advantage in being kept cold should have the cold air first.

The two most vital points, to be sure, are, first, that your circulating water through your coil (and water jacket around the compressor cylinder) is properly circulating. An item in connection with this is to see that this piping through which the circulating water is drawn from the sea and delivered to the cooling coil is well lagged, especially if it has to come through warm compartments, such as boiler rooms over boilers. Next, that when for any reason work is being done on any part of the system or valve chests or cylinders, great care is given to keeping the interior free from dirt and grit. A small scratch or score on the face of the compressor valve will very vitally affect the proper work of the machine. These valve surfaces must be tight and a lubricator installed to give them an occasional drop of oil. The oil must be of ice machine class, able to stand heat and cold. A good mineral oil from which paraffin is removed by freezing is suitable. All joints should be very carefully made, as air leaks do not take up, but get worse in time.

Once every three months a pressure of 60 to 70 pounds should be put on the pipes, and every part of every joint and every bolt head should be carefully inspected and tested by putting on a lather of soap with a brush, so that any leak will be easily detected by formation of air bubbles. These leaks must be stopped in a permanent manner. Joints are generally made with thin rubber gaskets and the joint painted with litharge and glycerine.

An occasional draining out of the bottom of the coils in the refrigerating rooms helps.

The whole piping system should once a year be steamed out and then blown out.

The machine should run at an average of 50 to 150 revolutions, according to the number of boxes or rooms being cooled or the volume of air being used.

All stuffing boxes on the machine piston rods should be well packed and kept tight. Be careful not to score the rods. Every tiny leak about the machine means loss of efficiency in refrigeration.

The piston leathers of the compressor and expander cylinders should last ordinarily about two months. They can be resoaked in castor oil and when swelled used over again. There should be a steel forming die (similar in construction to the piston in which the cup leathers are used), in which a spare set of leathers should be tightly clamped and formed. This die with the leathers in should be submerged in a can of castor oil. This treats the working edges of the leather to a soaking bath in the oil and keeps the main part of the leather that is clamped in the die or on the piston dry, the feature of this being that when the spare leathers are placed in use in the machine they will not require constant following up to squeeze out the oil and take up the slack.

The leathers should be made from oak-tanned leather slightly less than 1/8 inch in thickness and cut 5/8 inch to 3/4 inch larger in diameter than the cylinders, according to size. When these leathers give out, trouble will be experienced with a loss of pressure. Sometimes the high pressure decreases in relation to the low, and sometimes just one cylinder may lose pressure and the system shows a loss of cold.

The clearance of the setting of the primer pump that makes up the air leaks is also a very important item. It should be the very least possible with regard to safety in striking. About 3/64 inch is right. The clearance in any of the cylinders of the air part is very small, not over 1/8 inch, so that very little change is permissible in the wearing parts and they must be very frequently checked up. When removing and replacing the nuts on the piston rods when putting in leathers, the unscrewing of the rod or least movement of it in its crosshead must be guarded against. I think the change of these small clearances is probably what caused the breakage of the piston and the crosshead mentioned by F. C. W. C. H. W.

Feed Pump Valves

There is a matter concerning the effective lift allowable to feed-pump valves which is a case where practice contradicts theory.

The engineer to whom $\frac{\pi d^2}{4}$ and similar symbols concerning the values of the circle are familiar mysteries has always been through the demonstration that the lift of a valve should be 1/4 d. to give equal opening. Now, while the truth of this is not called into question, the expediency of allowing this amount of lift to every valve, irrespective of conditions, is a matter for question. Every valve of whatever type causes a loss of efficiency due to a factor impossible to do without; i. e., that of friction. The change in direction given to the flow of fluid causes a loss of head, and in the case of a feed pump an increased pressure to overcome. The impediment of the valve seat has the same effect. For the last reason alone at least 25 percent, and more often 33 percent, must be subtracted from theoretical lift for physical reasons.

The trouble with text-book formulæ is that in no case can they be applied except in the light of practical experience. They are absolute knowledge when of the $\frac{\pi d^2}{4}$ type, and most formulæ of a practical order involve an empirical constant or factor of ignorance based upon actual performance of known result.

The designer of feed pumps pays more heed, like all hydraulic engineers, to the question of velocities rather than simple displacement volume. For example, in centrifugal pumps the whole question is one of velocity, not of direct pressure. A centrifugal pump is the only type which will run with less horsepower when the delivery valve is closed and involves no danger from excessive pressure to pump or pipe line. The reason is obvious. Under these conditions the impeller revolves as a solid flywheel and no work is being done other than rotation. Speed in a centrifugal pump is based upon 10 feet per second flow, and most simple centrifugals are most economical at this speed. In other words, the speed of the extreme edge of the impeller is 10 feet per second, and a greater or less speed usually results in impaired efficiency. To obtain the quantity passed per minute it is merely necessary to calculate cross section of delivery, multiplying by 10 and by 60; the result is displacement of pump. Another view of a centrifugal pump is that it is a booster, and high lift centrifugals have the boosting feature in stages.

The bad feature of many common, simple centrifugals is that they absorb more horsepower with a low head and a consequently greater volume than when a higher head and lessened flow are the conditions of operation. For maximum efficiency it is necessary that the designed head and speed be kept constant. With a displacement pump, on the other hand, power absorbed is directly proportional

to lift and to close delivery with pump running may lead to disastrous results. For this reason relief valves are necessary and invariably fitted in the pipe line or adjacent to the pump.

To return from the velocity pump pure and simple to the more usual type, a reciprocating boiler feed pump of the duplex or other type usually has the delivery valve area more or less in accordance with the plunger area. This means that the velocity of flow through the pump valves is more or less the same as that imparted by the plunger; it is in a reciprocating pump of any description a series of squirts and not a steady flow.

Another matter is that to be on the safe side the normal feed pump is much in excess of the duty required to furnish sufficient water for boiler evaporation. In fact, with feed pumps on the main engine at least 75 percent of their stroke is not pumping at all; in some cases it is forcing air into the boilers if the gland be not unduly tight. It is not overstating facts to say that the majority of feed pumps fitted are capable of supplying up to six times the normal feed as a maximum quantity. Most duplex pumps are rated on a moderate speed, which may safely be very much increased. The catalogue duties are based upon piston speed; in other words, their maker's list them not from a displacement, but from a velocity point of view.

Feed pumps of the type indicated are provided in most instances with small, flat valves, several in number, on both suction and delivery sides. If these valves are given theoretic lift the area of opening to flow leads to shock conditions in feed pipes. In the case of main engine pumps from easily realized conditions the shock stress in the pipes is greater still, and few are the steamers so fitted which survive the passage of years without repaired feed pipes.

If the lift of the valves be reduced and the delivery area be lessened the plunger of pump works at an increased pressure and the velocity of flow through valves is increased. Such restriction of flow tends to lessen shock on pipes. Wherever feed pipes vibrate unduly it is pretty safe to reduce lift on pump valves. Experiment can determine the safe lift, and experiment alone; it is as well, though, to put a pressure gage on pump chamber to ensure that conditions resulting are not too severe.

Bad cases of pipe shock have been cured by adjusting the valve lift to the thickness of a post card, and this without unduly stressing pump.

The smaller lift equalizes the feed water, which then proceeds in regular increments, and not in sudden large gulps. Want of this simple expedient has frequently led to the substitution of a specially designed large slow and deliberate pump of an expensive type to replace existing gear fully equal to all demands had the conditions been properly analyzed. In practice it will not be denied that most check valve regulation on boilers is severe upon the pump. Half a turn to check valve is usual. This regulation of feed effects results at the expense of shock to feed pipes. This at least is the present contention. A steadying effect is thus obtained at the wrong end of the system, which by adjustment of lift on the pump valves might have been more properly obtained at the beginning and not the end of the flow. The noise and vibration only too often found, which is a source of worry and discomfort to the engineer on watch, can be effectively altered far the better in a large number of cases by diminishing the lift of the pump valves. If, therefore, feed pipes vibrate unduly it is as well to overhaul the lift of the delivery valves. In a number of instances a complete cure has been effected by a reduction in lift.

The whole question of valve design, whether stop, check or when unadjustable, as in pump valves at work, can do with revision. Flanges designed more to save metal than give rigidity and spanner clearance are too much in evidence. So familiar a mechanical accessory, having years of precedent to fix type, has led to neglect of overhaul from the designer's end. Few are the valves which one comes across that cannot be adversely criticised; starting with the hand wheel and ending with the joint faces, there is ample scope for improvement. Extra work is put where it is least necessary often enough, as in a highly polished hand wheel which has to be served with yarn before a satisfactory grip can be obtained. Flange faces are made smooth so that the joint is less secure; a wire feed in machining is preferable to flange and a distinctly rough hand wheel. Bolts and nuts are cheap enough to substitute six or eight for the too frequently noticed four. Smaller bolts and more of them are needed with the yielding type of flange in gun metal, which is a perpetual sore place, not to mention ⅜- or ½-inch valves with oval flanges and two bolts.

The designer should be more generous in spirit in the weight of metal allowed. Most of the troubles experienced are impossible to effectively remedy when the job has been made up and is in being, causing daily annoyance to the engineer. The question of weak flanges alone has been a gold mine to the maker of patent packings and jointings. While the amount of skin lost from knuckles in the course of a year would cover an ordinary steamer's deck, laid (as the statisticians put it) end to end, from insufficient flange area and slipping spanners. One-thirty-second turn for each adjustment of the spanner to the nut is slow and wearisome work, and only too rarely are snugs fitted to the bolts. In small valves the wheels are too tiny for a big fist. There is a limit microscopically in this direction, while in large numbers of cases a wheel spanner whose use is only too common testifies to the insufficient size of the wheels in larger sized valves.

The critcisms do not apply universally, since there are makers who exclusively deal with valves. Some of these turn out a decent article, but the ideal valve is yet to seek. Vast numbers of such fittings for boilers and elsewhere are the poorest of goods marketed for sale only. To protect their customers many engine firms make their own valves, and, since design is not a specialty confined to a few makers only, it is hoped the remarks here tendered may serve to give a pause for reflection and lead to better things. If the spirit of rational criticism is once evoked and draftsmen and others responsible start to look upon existing practice with a critical eye there is little doubt that remedy will be effected. Where danger to life and limb are involved a small extra cost should not be allowed to stand in the way of safety first, which is a policy we all agree to subscribe to in spirit. No precaution is too costly to obviate troubles where risk is assumed daily, as where steam pressure is carried and where the remedies are known and easily applied it leaves little excuse after the event, if and when it happens.

A. L. HAAS.

London.

TWO HUNDREDTH ANNIVERSARY OF BOSTON LIGHT.—A small bronze tablet, bearing the inscription, "Boston Light, built at this place by the Province of Massachusetts, was first lighted September 14, 1716, Old-Style; destroyed 1776 and rebuilt 1783," and in small letters beneath, "This tablet has been placed by the United States Lighthouse Service, September 25, 1916, in commemoration of the two hundredth anniversary of the first lighthouse in America," was unveiled on September 25 at Boston Light Station at the entrance to Boston Harbor, Massachusetts.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, and defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Defects in Indicator Cards

Q.—The inclosed indicator cards are from a small twin-screw steamer. Will you kindly make an analysis of the cards? It appears that the defects shown have always existed since the ship was built, and I am anxious to have your opinion as to the alterations that should be made to make the engines more economical. E. B. E.

A.—The high pressure cards are as good as one would wish. It is difficult to say just what may cause the disturbance in the admission lines of the low pressure cards. The lead appears somewhat insufficient for the bottom cards, and if this were increased a slightly better card would probably result. The bump in the middle of the admission line is probably merely a normal effect of the high pressure release into the receiver (assuming that this is a quarter crank engine). It is doubtful if the cards can be much improved upon. Oscillations in the admission line often appear in cards taken with a weak spring and are due to vibration of parts of the indicator.

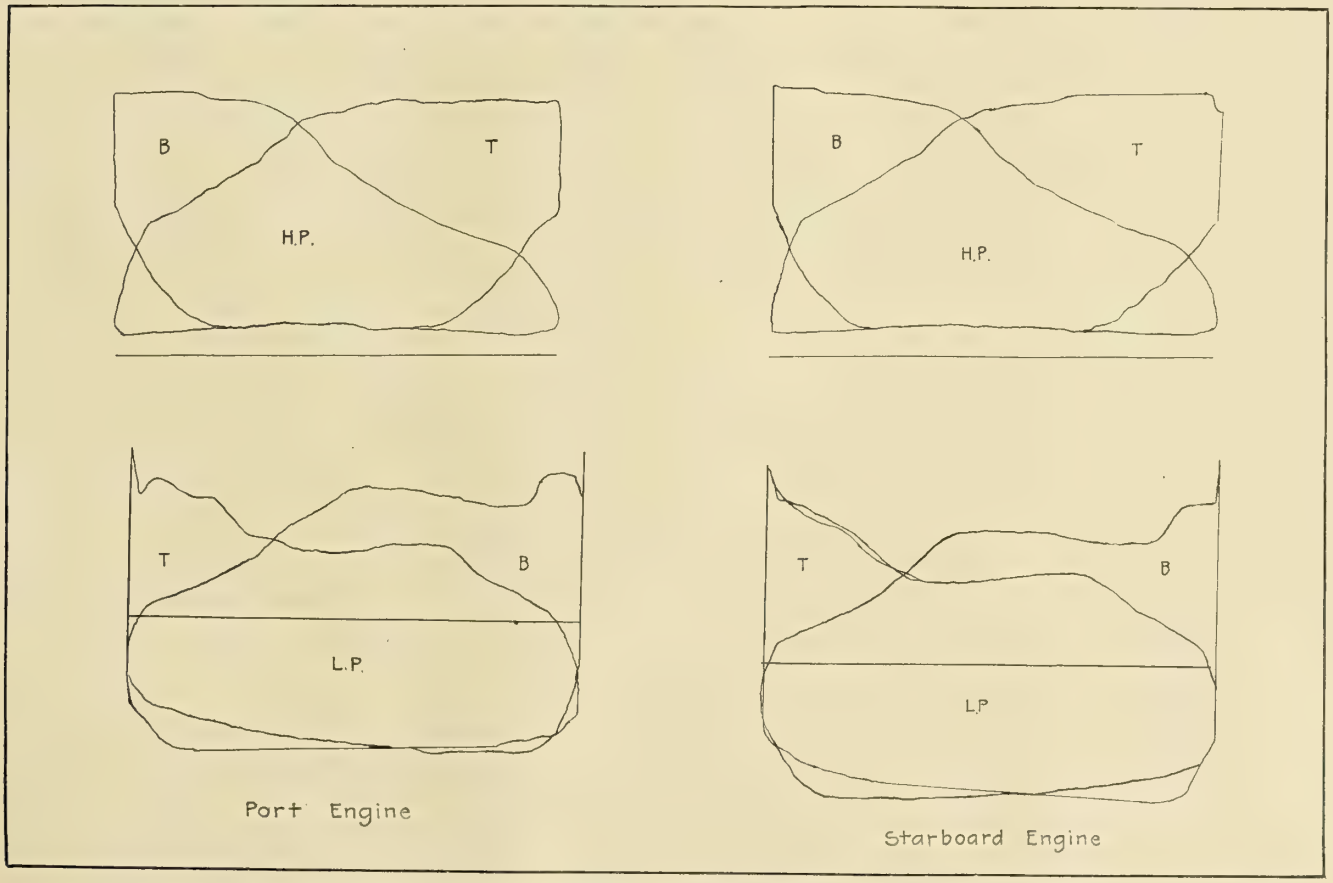
* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

Absorption of Water by a Gas

Q.—Can you give me a formula or table for the weight of water that a gas at any temperature and pressure will absorb when in contact with the free surface of the water? I have a formula that gives negative values for the weight of water that pure air will contain at any pressure and temperature when I substitute the pressure and temperatures of saturated steam—why is that? R. D. K.

A.—The question is too vague for a definite answer. If you will send in a specific problem, I will try and give the solution. There are tables published for the amount of water vapor which air will sustain without condensation, and the following is abstracted from one of these:

Temp. of air, degrees F.	Weight of water vapor per cubic foot, pounds
32	0.000304
40	0.000410
50	0.000587
60	0.000827
70	0,001145
80	0.001564
90	0.002121
100	0.002850
200	0.02976
212	0.03738



Indicator Cards from Compound Engines; 13 x 30 x 24 Inches on Twin-Screw Steamer, Boiler Pressure, 155 Pounds per Square Inch; Vacuum, 24 Inches

Books on Wooden Shipbuilding

Q.—Would you kindly inform me if there is a treatise on modern wooden shipbuliding similar to Holms' "Practical Shipbuilding" of steel vessels? Please recommend also books on shipyard management. E. S.

A.—There is no modern treatise on wooden shipbuilding. The best work on this subject is the classical one by Thearle entitled "Naval Architecture," published many years ago, but still good for wooden ship construction. This is not his treatise on "Iron Shipbuilding." The publishers are G. P. Putnam's Sons, 2 West 45th street, New York.

I know of no book that deals specifically with shipyard management. An excellent book which covers cost estimation and some phases of modern planning and routing is "Estimating the Cost of Work," by W. B. Ferguson, published by the Engineering Magazine Company, New York.

Power for Driving Propeller

Q.—Will you please advise if there is any simple formula fairly accurate for calculating the horsepower required to turn a propeller of given diameter, pitch and blade area a given number of revolutions? P. P.

A.—There is no formula involving only the variables you mention which will permit the estimate of the power absorbed by a propeller (the power delivered by the engine to the propeller) with any reasonable accuracy, as the data are insufficient in themselves to determine its action. Slip is a function of prime importance in propeller operation and must be taken account of either directly or indirectly (as speed) in any expression for the prediction of power. For example, a given propeller drives a ship at a definite speed when turning at certain revolutions per minute; now, suppose that, due to additional resistance, such as towing or added displacement, the same revolutions per minute drive the ship only three-quarters as fast, the indicated horsepower to maintain this same revolutions per minute would have increased and nearly proportional to the slip increase.

Most of the design or analysis of propellers is now done by means of the results of experiments on model or full-sized propellers, as published in the books of Taylor[1] or Dyson[2], and these take account of all the variables which affect actual propeller performance. Admiral Taylor has recently published* the following expression as representing approximately and through the range of propellers commonly met with, the horsepower absorbed by a three-bladed elliptical contour propeller, and this is the best single expression of propeller performance available:

$$P = \frac{0.88 + \frac{0.69}{a} + \left(1.3 + \frac{10.3}{a}\right) t}{1 - s} \left(\frac{p R}{1{,}000}\right)^3 \frac{d^3}{p}$$

in which the letters have the following significance:

P represents horsepower absorbed by propeller (the brake horsepower of engine).
d represents diameter of propeller in feet.
p represents pitch of propeller in feet.
a represents pitch ratio, which is $\frac{p}{d}$.
R represents revolutions per minute.
s represents real slip (not apparent slip).
t represents blade thickness fraction (thickness of radial blade section at axis, if lines of face and back are extended, ÷ diameter).

The effect of the blade thickness fraction t is of minor importance, and if we accept a value of 0.06 for t, which is reasonable for general practice, the above expression simplifies into the following:

$$P = p^2 \left(\frac{R\,d}{1{,}000}\right)^3 \left[\frac{0.96 + \frac{1.31\,d}{p}}{1 - s}\right]$$

Value of slip for best efficiency should lie between 0.20 and 0.35.

Four-bladed wheels will take approximately 1.25, and two-bladed wheels approximately .75 of the above.

[1] Speed and Power of Ships. D. W. Taylor.
[2] Screw Propellers. C. W. Dyson.
* Paper before International Engineering Congress, San Francisco, 1915.

Effect of Throttling of Superheated Steam

Q.—Does superheated steam retain its superheat after excessive throttling? On ships where steam at boiler pressure is supplied to the auxiliaries more or less throttling is to be found, except perhaps only in the case of the feed pumps; the ballast pump, for instance, will usually be working with the steam stop valve only slightly opened; assuming now that the steam in the main at the pump is 170 pounds pressure and is superheated to 300 degrees C., will it still be superheated if pressure in the steam cylinder is reduced to, say, 100 pounds by throttling? If so, please give rule for finding temperature after throttling. Where can results of tests covering this be found? G.

A.—The interesting phenomenon of throttling in the thermodynamic meaning of the term occurs when there is an expansion without the addition or subtraction of heat (adiabatic action) under such conditions that the energy available from unrestricted expansion is used up in overcoming the internal resistances. The action is adiabatic, but not isoentropic, and the solution of problems is made possible by the fact that it is an adiabatic process; i. e., that no heat has been added or taken away; that no work has been done, and therefore that the heat contents is the same at the end of the operation as at the beginning. The actions met with in actual practice occur so quickly that there is no appreciable error in assuming them adiabatic, and it makes no difference whether the steam is saturated or superheated at the start. It will have the same heat contents at the lower pressure that it had at the start, and will therefore be in a dryer or more superheated condition at the finish than in the high pressure condition.

In the problem given, steam at 170 pounds absolute, superheated 540 degrees F. (300 degrees C.), has a heat contents of 1,470 British thermal units (temperature = 910 degrees F.) Now, as no heat enters or leaves the steam and none is transformed into work, this is the heat contents at the lower pressure of 100 pounds, and it is only necessary to find from the steam tables or diagrams the condition of the steam at this pressure and heat contents.

It is superheated 575 degrees; the temperature, therefore, is obtained by adding the number of degrees of superheat to the saturation temperature of the steam at 100 pounds pressure absolute, or 328 degrees + 575 degrees = 903 degrees F.

References for experimental work on throttling are difficult of access, as the work of Grindly, Griessman, Peake, Joule and Kelvin are available in the original papers only, but an excellent discussion of the whole subject is given in Goodenough's "Principles of Thermodynamics," pp. 268-282 (published by Henry Holt & Co.). The solution of problems, however, is made from tables or diagrams of the properties of steam, such as Peabody's or Davis and Mark's.

Laying Up Boilers

Q.—I am going to lay up a couple of boilers for four months. Would you recommend using boiler compound in the water left in them? F.

A.—No. Run the water through an evaporator if possible and fill completely with evaporated water, taking care to see there is no excess alkalinity (over ½ percent) and that the boilers are filled full; also that the zincs are in good condition.

Shipbuilding and General Marine News

Contracts for New Ships—Marine Terminal Improvements—Recent Launchings—Improved Appliances—Personal Items

Steel merchant vessels building or under contract to be built in private American shipyards on October 1, according to builders' returns to the Bureau of Navigation, Department of Commerce, number 417 of 1,454,270 gross tons. On June 30 Lloyd's Register reported 439 steel merchant vessels of 1,540,118 gross tons under construction in British shipyards. The American returns cover contracts on which work has not begun, while Lloyd's returns cover only ships on which construction has actually begun. Although British yards have increased their merchant work, the delivery of engines and machinery is slow, and at present the completed output of American and British yards are about equal. During September, American yards finished 19 steel merchant vessels of 46,608 gross tons and made new contracts for 47 steel merchant vessels of 208,686 gross tons, about half of which is for Norwegian owners. The month's new contracts equal all the merchant steel tonnage in the United States building or under contract on July 1, 1913, and exceed that on July 1, 1914.

Shipbuilders expect to launch during the current fiscal year 326 vessels of 998,035 gross tons, and in the fiscal year ending June 30, 1918, 91 vessels of 456,235 gross tons. These dates of launching, of course, are subject to the usual allowances for delays.

Shipbuilding Contracts

The Navy Department, Washington, D. C., opened bids on October 25 for four battleships (price within $11,500,000 each) and twenty torpedo boat destroyers (price within $1,200,000 each). In spite of the increase in the cost of shipbuilding the Department was successful in receiving bids for all classes of these vessels within the cost limit set by Congress. Bids were received from the New York Shipbuliding Company, Camden, N. J.; the Fore River Shipbuilding Corporation, Quincy, Mass.; the Newport News Shipbuilding & Dry Dock Company, Newport News, Va.; the California Shipbuilding Company, Long Beach, Cal.; the Seattle Construction & Dry Dock Company, Seattle, Wash.; Bath Iron Works, Bath, Me., and the Union Iron Works, San Francisco, Cal. It is considered probable that two of the four battleships (*Colorado, Maryland, Washington, West Virginia*) will be built by the Fore River Shipbuilding Corporation and two by the Newport News Shipbuilding & Dry Dock Company.

Inquiries have been made among Atlantic coast shipyards for the construction of more than fifty ships for 1918 delivery, and actual contracts for 1918 delivery have been placed with shipyards on both the Atlantic and Pacific coasts.

The Seattle Construction & Dry Dock Company, Seattle, Wash., has received a contract to build three steamers for 1918 delivery.

The Sun Shipbuilding Company, 1428 South Penn Square, Philadelphia, Pa., has received a contract to build two 10,000-ton freight steamships for the Shawmut Steamship Company, Boston, Mass.

The Hanlon Shipbuilding Company, Oakland, Cal., has received a contract from the Western Fuel Company, San Francisco, Cal., to build a 3,500 ton auxiliary schooner.

The Standifer-Clarkson Company, Astoria, Ore., has received an order to build a 250-ton Diesel-engined ship to be known as the *Maid of Douglass*.

The Heath Shipbuilding Company, Portland, Ore., is stated to have received contracts to build six auxiliary schooners for Norwegian interests. These vessels are to be 266 feet long with a deadweight capacity of 3,000 tons.

The Washington Shipping Corporation, Seattle, Wash., states that work will be begun in November on its first vessel. The company has several auxiliary wooden schooners nearing completion at its Harbor Island plant.

The Navy Department, Washington, D. C., will receive bids on November 1 for four scout cruisers and twenty-nine submarines.

The Navy Department, on December 6, will receive bids for building four battle cruisers.

W. G. Abbott, Milford, Del., is building a wooden steam lighter for the Baltimore & Ohio Railroad Company, Baltimore, Md.

The Benecia Shipyards, Benecia, Cal., have received a contract to build a 200-foot river steamer to cost $130,000.

The Olympia Shipbuilding Company, Olympia, Wash., has been organized, and is reported to have received contracts to build four auxiliary schooners, each about 290 feet long.

The Bethlehem Steel Company, South Bethlehem, Pa., has received an inquiry from the Argentine Government covering the construction of a fleet of merchant ships at a cost of approximately $25,000,000.

The Isthmian Canal Commission, Washington, D. C., will soon call for bids for the construction of two colliers authorized by Congress, to cost not more than $1,500,000 each.

The Sharptown Marine Railway Company, Sharptown, Md., has a contract to build a steamer 163 feet long for the White Shipping Company, Laurel, Md.

The Gray's Harbor Shipbuilding Company, Aberdeen, Wash., has received a contract to build two power schooners for the Gaston, Williams & Wigmore Steamship Corporation, New York.

The American Car & Foundry Company, Wilmington, Del., has received contracts to build wooden boats exceeding 20,000 gross tons.

The Pacific Steamship Company Seattle, Wash., is planning the early construction of two 20-knot passenger and freight steamships to cost about $1,500,000 each. This company is the new name of the Pacific Coast Steamship Company and the Pacific-Alaska Navigating Company, which have been combined under one corporate head. The president of the new company is H. F. Alexander, Tacoma, Wash., and the manager is A. F. Haines, Seattle.

The Greenport Basin & Construction Company, Greenport, L. I., will build two submarine chasers 40 feet long, one to be used at each end of the Panama Canal.

The Pusey & Jones Company, Wilmington, Del., has received a contract to build four more steamships for Norwegian owners.

The Moore & Scott Iron Works, San Francisco, has received an order from B. A. Sanne, of Christiania, Norway, for a 9,400-ton cargo steamer fitted with Curtis geared turbines and Scotch boilers.

According to the Oakland Chamber of Commerce approximately $50,000,0000 worth of work is now being done or has been contracted for by Oakland shipbuilding yards. One-sixth of the iron and steel shipbuilding in this country is being done on San Francisco Bay. One-fourth is on the Pacific Coast.

Thirty-seven ships, with a tonnage capacity of 292,000, of which eleven are wooden vessels of the class of semi-Diesel auxiliary power propellers, with a tonnage of 77,000, are being constructed in the Pacific Northwest, according to a report by W. B. Henderson, United States commercial agent at Seattle. The steel vessels, twenty-six in number, have a capacity of 215,000 tons, and of this number four are contracted for by the United States Government. The value of vessels under construction and contracted for aggregates $32,000,000.

Six auxiliary wooden schooners for Norwegian account are reported to have been booked by the Heath Shipbuilding Company, of Portland, Ore. Delivery of the first vessel is to be made in ten months, the second in eleven months, and one thereafter every sixty days, with the sixth ship ready to turn over to her owners in nineteen months from the date of the contract. The vessels will be of the topmast type, 266 feet long, with beam of 45 feet and 25 feet molded depth. Their lumber-carrying capacity is to be 2,100,000 feet and deadweight capacity 3,000 tons. Three will have twin semi-Diesel engines of 240 horsepower and three of 385 horsepower, all of the Skandia type.

Two-thirds, or about 10,000 tons, of the steel plates entering into the construction of five Norwegian steamers to be built by J. F. Duthie & Co., of Seattle, will be fabricated at the plant of the Northwest Steel Company, at Portland. With the seven steamers it had previously signed contracts to build at Portland, this will make practically twelve Norwegian steel

vessels for which the Northwest Steel Company will fabricate the material. The fleet will have an approximate value of $12,000,000.

Including those being turned out at St. Helens, which is in the Portland customs district, more than $16,000,000 worth of ships is being turned out at Portland.

Contracts for structural steel for the new hospital ship being built at the Philadelphia navy yard and the fuel ship at the Boston navy yard were awarded October 4 by the Navy Department at prices about 33 percent higher than were paid for similar material last December.

Shipyard News

Jose Marimon, president, Banco Espanol, Havana, Cuba, has acquired control of the Standard Shipbuilding Corporation, 44 Whitehall street, New York City. It is the intention of the new management to expend about $2,000,000 in developing the plant at Shooters Island, N. Y. New slips and power houses will be built to increase the capacity of the yard to sixteen ships. A considerable portion of this expenditure will be for equipment, including machines and pneumatic tools, cranes plate bending rolls, punching and shearing machines, hydraulic presses, etc. Orders for a portion of this equipment have already been placed. At the present time six steamers for foreign delivery are being built at the plant, each of which requires approximately 3,000 tons of steel. The first of these steamers is to be delivered about December. The officers of the company are Jose Marimon, president; Wallace Downey, first vice-president and general manager; W. R. Bush, second vice-president, and Henry W. Baird, secretary and treasurer.

The Pan-American Shipbuilding & Salvage Company has been organized in New Orleans, La., with offices suite 925, Whitney building. It is reported that the new company will have a capital stock of $1,000,000, that a site has been selected on the Mississippi River near New Orleans, and that keels of four four-masted schooners will be laid in a few weeks. The new concern is in the market for the usual ship supplies and wood-working machinery.

The Vancouver Shipbuilding Company has been organized in Vancouver, Wash., by James Feeney and G. B. Percival. The new company has secured a site for its plant and is reported to have already received a contract to build a wooden sailing vessel.

The Board of Trade, Orange, Tex., is promoting the organization of a company in Orange, Tex., to build a shipbuilding and repair plant to cost about $150,000.

The Columbia Engineering Works, Portland, Ore., plans to build another set of ways for ship construction.

The Dumphy Boat Works, Eau Claire, Wis., will build a new factory building.

Improvements planned by the Pusey & Jones Company, Wilmington, Del., include a 70 by 200-foot shop, equipped with traveling cranes, punches and shears. Another building 50 by 300 feet will also be constructed.

The Vancouver Shipyards, Ltd., Vancouver, B. C., are considering trebling the size of their yard.

The Seattle Construction & Dry Dock Company, Seattle, Wash., will soon begin work on the construction of a 12,000-ton floating dry dock.

The Sun Shipbuilding Company, Philadelphia, Pa., is expected to have its yard in Chester, Pa., ready to build ships before the end of this year.

It is reported that Pittsburg capitalists will build a $1,000,000 shipbuilding and dry dock plant at San Diego, Cal., and that the new concern has already received contracts to build six 2,000-ton steamships for George Culver, Los Angeles, Cal.

The Heath Shipbuilding Company, Portland, Ore., has secured a site in South Portland for its new plant. George E. Hardy and E. W. Heath, Portland, are among the incorporators. The company is incorporated at $100,000, and will have four building berths.

John Martinolich, Tacoma, Wash., has drawn plans for the shipyard of the new Northern Shipbuilding Company, Tacoma, of which he is president. The company is reported to have already received contracts to build several wooden vessels.

The plant of the F. C. Smith Shipbuilding & Dry Dock Company, Norfolk, Va., established nineteen years ago by F. O. Smith and George W. McCoy, has passed into the hands of five prominent men identified with the marine railway business in Norfolk. The name of the firm will not be changed. George W. Roper, president of the Norfolk Marine Railway Company, is president, and B. C. Colonna, of the Colonna Marine Railway Corporation, is secretary.

Control of the Delaware Shipbuilding Company, Seaford, Del., has been secured by Mr. V. Johnsen, president of the ship brokerage firm of Hennevig & Johnsen, Inc., New York. Under the new management the firm will make a specialty of building large wooden schooners.

The Fore River Shipbuilding Corporation, Quincy, Mass., is making preparations for constructing the largest vessels called for by the recent naval appropriations. Plans have been made for lengthening two slips to accommodate battle cruisers.

New ways are rapidly nearing completion at the yard of the Pusey & Jones Company, Wilmington, Del., to accommodate the building of steel vessels of much larger tonnage than was possible hitherto.

The Bay Point Marine Ways at Pensacola Bay has installed a complete plant, enabling the firm to haul out and repair much larger vessels than could be handled formerly.

The William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., has let contracts for the construction of four large shops, including pipe and ship shops and a power plant.

The Mare Island navy yard, San Francisco, Cal., is now employing 2,940 men, the weekly payroll amounting to $59,000. The first actual work on the building of the battleship *California* at this yard was begun on September 13.

At the Portsmouth navy yard, Portsmouth, N. H., the unusual amount of work on hand is delayed on account of lack of skilled and unskilled labor. Two hundred additional skilled mechanics could be employed at once.

The new 1,000-foot dry dock at Balboa on the Panama Canal is virtually completed. The dock is 110 feet wide and has a depth of water over the blocks of 35 feet at mean tide and 45 feet at high tide. With the terminal shops and foundries this plant is equipped for doing practically any sort of ship repair work.

Recent Launchings

The Maryland Steel Company, Sparrows Point, Md., launched on September 28 for the Bull Insular Steamship Company, New York, the steamship *Helen,* 338 feet long by 46.6 feet beam by 26.3 feet depth of 3,800 gross tons and 12 knots speed.

The Tampa Foundry & Machine Company, Tampa, Fla., launched on September 23 the steamer *Poughkeepsie,* designed by J. W. Millard & Bro., naval architects, New York, for the Central Hudson Steamboat Company. The vessel is 216 feet long by 36 feet 6 inches beam by 15 feet depth, and is designed to operate between New York and Kingston.

The Chicago Shipbuilding Company, South Chicago, Ill., launched on October 14 the steamship *Mantua,* 261 feet long by 43 feet beam, which is being built for the Gulf & West Indies Steamship Company to ply between Atlantic ports and the West Indies.

The Harlan & Hollingsworth Corporation, Wilmington, Del., launched on October 13 the steamship *Georgeanna Weems,* 225 feet long by 39 feet beam by 26 feet deep, with a cargo-carrying capacity of 1,700 tons, which is being built for the Baltimore & Carolina Steamship Company.

The William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., launched early in October the new car ferry *Joseph R. Parrott,* a duplicate of the *Henry M. Flager,* for the Florida East Coast Railway Company to operate between Key West and Havana.

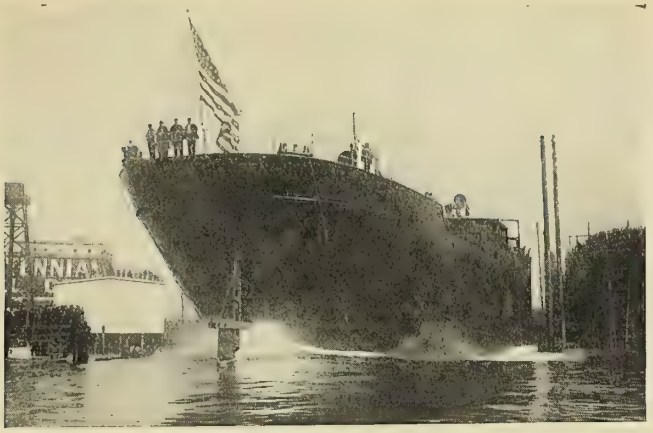
The Moore & Scott Iron Works, Oakland, Cal., launched on October 14 the 7,100-ton turbine steamship *Capto,* under construction for Hon. James Rolph, Jr., Mayor of San Francisco.

The California Shipbuilding Company, Long Beach, Cal., launched on September 28 the United States submarine *L-7.*

The Seattle Construction & Dry Dock Company, Seattle, Wash., launched on September 23 the 6,000-ton freighter *Cauto,* 368 feet long by 47.9 feet beam by 27.3 feet depth, for the New York & Cuba Mail Steamship Company (Ward Line).

The Kruse & Banks Shipyard launched on September 26 the steam schooner *Port Angeles,* 235 feet long by 42 feet beam of 15 feet 6 inches depth, for the Charles Nelson Company, San Francisco, Cal.

The schooner *Columbia River,* which has a capacity of 1,500,000 feet of lumber, was launched at Aberdeen, Wash., on September 30.





Views of the Launching of the S. S. *Niels Nielsen* at the yard of the Skinner & Eddy Shipbuilding Corporation, Seattle, Wash.

Forty-Four Merchant Ships to be Equipped with Westinghouse Geared Turbine Propelling Machinery

Orders totaling more than $2,700,000 have recently been received by the Westinghouse Machine Company, of East Pittsburg, Pa., for equipping with propelling machinery 44 merchant ships now under construction or contracted for at the yards of shipbuilding companies on both the Atlantic and Pacific coasts. The company also has in immediate prospect the equipping of 16 merchant ships in addition to the 44 above mentioned, bringing the total number of ships up to 60, and the total value of the orders for machinery to be supplied by the Westinghouse Machine Company to approximately three and three-quarter million dollars.

The ships are to be equipped with the latest refinements in the line of propelling machinery, consisting of Westinghouse turbines with double reduction gears, and with few exceptions condensing equipment. The first ship which has been so equipped is the *Malmanger,* launched at the Chester Shipbuilding Company, Chester, Pa., on August 26, 1916.

The business above described covers strictly merchant ships, and does not include orders received for propelling machinery for the United States Navy or for foreign governments.

First Launching at Skinner & Eddy Shipyard

On September 21 the first ship built at the newly organized shipyard of the Skinner & Eddy Corporation, Seattle, Wash., was launched, with due pomp and ceremony, for Mr. B. Stolt-Nielson. She is the *Niels Nielsen,* and will fly the Norwegian flag, her port of registry being Haugesund, Norway. She is the first of a number of her type being built. Her sister ship, the *Hanna Nielsen,* will be launched about a month later.

The general dimensions of the ship are: Overall length, 423 feet 9 inches; beam, 54 feet; depth, 29 feet 9 inches; load draft, 24 feet 2 inches; speed, 11½ knots; deadweight, 8,800 tons. She is a single-screw ship of the poop, bridge and forecastle type, with two decks and machinery amidships; being built under the survey of Lloyd's to Class 100-A-1, and is the largest cargo ship so far built in the Northwest.

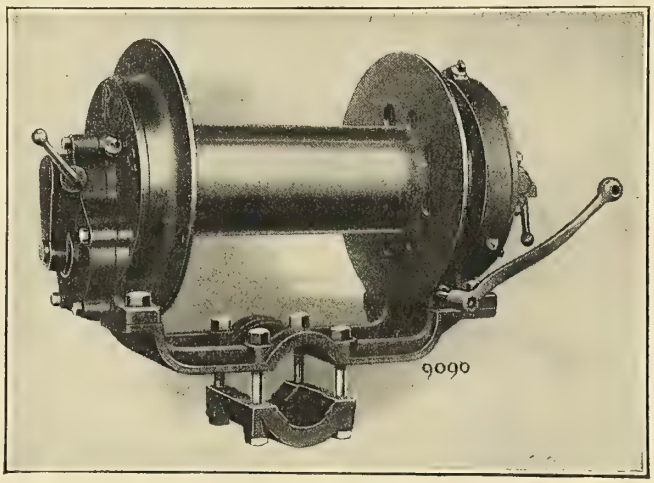
She will be equipped with three Scotch marine boilers, 14 feet 9 inches in diameter and 11 feet long, having 2,680 square feet of heating surface and a working pressure of 210 pounds per square inch, burning oil or coal. They are being built by the Commercial Boiler Works. These will furnish steam to Curtis turbines of the General Electric Company's manufacture, developing 2,500 shaft horsepower at 100 revolutions per minute, geared to the shaft driving a four-blade propeller of 16 feet 5 inches diameter. There will be five stages in the ahead and two stages in the reverse turbine.

For the handling of cargo this ship is equipped with two masts, having four 5-ton booms and one 30-ton boom and two derrick posts, each fitted with one 3-ton boom. There are five main cargo hatches.

The keel of this vessel was laid on May 2, but actual construction work was not started until June 6. From this date on the work progressed rapidly and smoothly under the direction of Mr. David Rodgers, the works manager, formerly of the Seattle Construction & Dry Dock Company; and due to his efforts and able management this early launching date became a possibility. Immediately upon launching the keel blocks were prepared and the keel of contract number seven was laid.

New Model Little Tugger Hoist

For the use of those who prefer manila rope to wire rope for light hoisting and hauling, the Ingersoll-Rand Company, New York, has brought out a new model "little tugger" hoist which is designated No. 11. The square piston, reversible driving engine, automatic lubrication, enclosed gearing, drum release clutch and worm-operated band brake, are essentially the same as in the No. 1 model manufactured by this company. The main differences are in the diameter and length of the drum, the width of the flanges, and, necessarily, the main frame and overall dimensions.



Little Tugger Hoist

The new No. 11 "little tugger" has a hoisting drum 7 inches in diameter by 17 inches long with 5-inch flanges. This accommodates 300 feet of ⅞-inch manila rope. The maximum capacity of this hoist is conservatively rated at 600 pounds. The weight of the hoist itself is 358 pounds. It is 21½ inches long, 31¼ inches wide and 23 inches high.

Like the No. 1, the No. 11 "little tugger" is built for operation both by compressed air and steam. The standard clamp fits a 4½-inch diameter column or pipe, but by removing the clamp the hoist can be readily bolted directly to any convenient support, timber, flooring, etc. The device is recommended by the manufacturers for all around hoisting, hauling and handling in industrial plants.

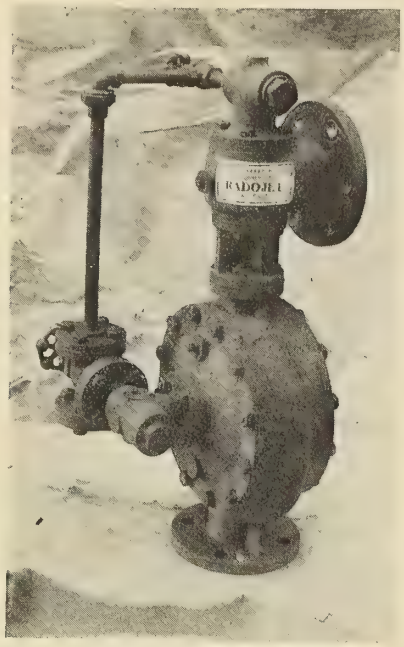


Fig. 1.—"Radojet" Air Pump

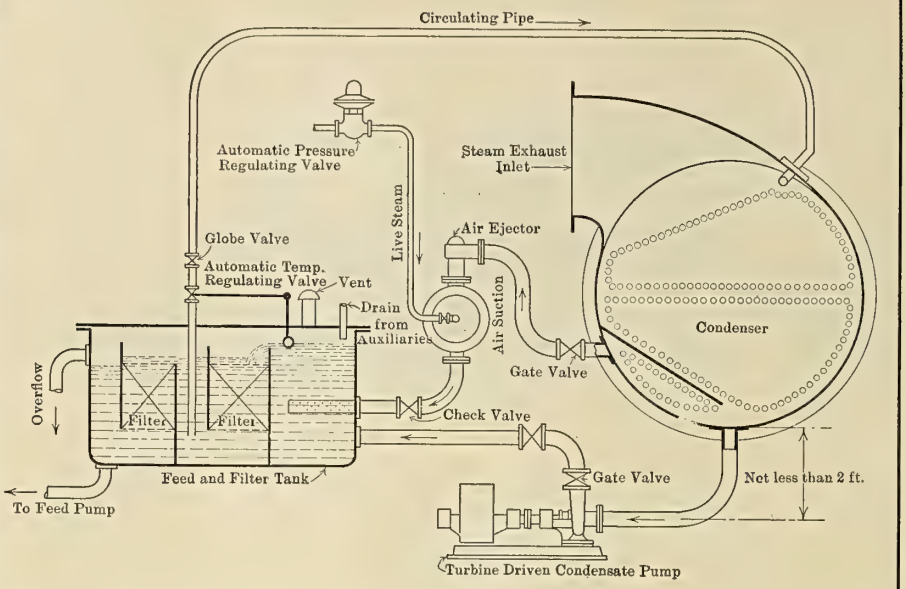


Fig. 2.—Diagrammatic Arrangement of "Radojet" Air Pump in Marine Condensing Plant

The "Radojet" Air Pump

A new type of air pump, called the "Radojet" Air Pump (Patented) for producing highest possible vacuum economically, was recently introduced by the C. H. Wheeler Manufacturing Company of Philadelphia. Usually a radical improvement in economy or efficiency is attained by increased complications. In this air pump, however, the improvements were attained by simplification.

The new device is a substitute for any air pump working on the dry air principle, of either the reciprocating, rotative, rotary or hydraulic entrainment type. It has no piston or valves, and is operated by live steam jets which by passing through nozzles of patented design obtain a high velocity that entrain the air and non-condensable gases from the condenser and compress same to atmospheric pressure.

Fig. 1 shows a Radojet air pump for a surface condenser condensing about 20,000 pounds of steam per hour. The size of this pump is extremely small, requiring very little space.

A diagrammatic arrangement of the Radojet air pump as used on marine surface condensers for turbines is shown in Fig. 2. The exhaust steam from the pump is discharged into the feed tank in a condensed form, and serves to raise the temperature of the feed water. In other words, all the heat contained in the live steam used for the operation of the pump is utilized, thus giving, it is claimed, a thermal efficiency of practically 95 percent. The condensed steam is taken from the hotwell of the condenser by a turbine or electric driven condensate pump and discharged into the feed water tank, where it mixes with drains from other auxiliaries and the exhaust steam coming from the Radojet air pump. A separating wall with an overflow is provided to force the water to rise, thereby freeing the air which escapes through a vent arranged on the top cover of the feed tank.

The Radojet air pump may be located at any convenient place close to the condenser. The air suction should be arranged a little higher than the air suction of the condenser, so as to form a drain towards the condenser.

An automatic steam pressure regulating valve is supplied with the Radojet air pump, which should be arranged somewhere in the highest point of the live steam line. Its purpose is to maintain a constant steam pressure at the inlet of the air pump, thereby insuring a uniform steam consumption with varying boiler pressure.

The back pressure on the exhaust of the Radojet air pump should not exceed one-half pound gage. A circulating pipe with a float-operated valve is also seen in Fig. 2. The object of this circulating pipe is the following: If the main engines of a marine installation come to a sudden stop, as is frequently the case when maneuvering, very little water will be discharged by the condensate pump to the feed tank. The Radojet pump being in operation, steam will continuously enter the feed tank, and the heat contained in the steam will cause an increase of temperature of the water in the feed tank, which may soon reach the boiling point unless some additional water supply is provided for; the float-operated regulating valve and the circulating pipe serve this purpose. As soon as the quantity of water supplied to the feed tank becomes smaller, the water level in the first compartment of the tank will fall, thereby opening the automatic regulating valve and allowing some water to be sucked into the condenser through the circulating pipe. This water by falling down over the cooled tubes will be reduced in temperature and will be returned by the condensate pump to the feed tank, thus preventing boiling.

The Radojet air pump may also be used with advantage with reciprocating engines where lower vacua than those provided for on turbine installations are required. The reciprocating air pump, which is generally operated directly by a lever connected with links to the crosshead of the main engine, will be replaced by the Radojet air pump removing the air, with a small direct-acting hot well pump for removing the condensed steam from the condenser.

The advantages of this new device may be summarized as follows:

1. Extreme simplicity and consequent ease of manipulation and operation. The apparatus is static. All that is required to start it is to open the steam valve; and to stop it, to close the same. No attention is required during its running.
2. Minimum space requirements as compared with other types of vacuum producing apparatus, the space occupied being about one-tenth of that of an ordinary reciprocating pump.
3. Minimum weight, the weight being about one-sixth that of a reciprocating air pump.
4. Complete absence of internal moving parts, so that wear is eliminated and the efficiency does not drop off after long periods of operation.
5. Great flexibility in locating the apparatus, which is of importance for marine installations.
6. Highest efficiency, the steam consumption of the apparatus being less than that of the reciprocating air pump.

Wooden Shipbuilding Offers Employment for Skilled Labor in Portland, Ore.

With twenty-seven ships either under construction or contracted for at Portland, Ore., the city expects that the industry will become an important and permanent employer of skilled labor.

Shipbuilding on the Columbia and Willamette rivers of



Banquet to Shipbuilders of the Northwest Given by the Manufacturers' Association of Seattle at the New Washington Hotel, Seattle, Wash., on September 21

Oregon begins in the yards at Astoria, at the mouth of the Columbia, is in progress at St. Helens and at half a dozen yards in close proximity to the big sawmills along the waterfront at Portland. Auxiliary power ships comprise the majority of the construction.

Oregon has one-fifth of the standing timber of the United States, a fact which should give shipbuilders an advantage that will insure employment to large numbers of carpenters for many years.

It is thought that it will require a period of years to restore anywhere near the amount of tonnage that has been taken from the seas as a result of the European war, and that the development of the auxiliary power craft will always make the wooden ship a competitor for certain lines of business.

Banquet of Northwestern Shipbuilders

Commemorating the event of the Northwest's début as a great shipbuilding center, ushered in by the launching of the 8,800-ton steel cargo steamer *Niels Nielson* at the plant of the Skinner & Eddy Corporation on September 21, and followed immediately by the launching of the 5,250-ton steel steamship *Cauto* at the plant of the Seattle Construction & Dry Dock Company on September 23, a banquet given under the auspices of the Manufacturers' Association of Seattle to the shipbuilders of the Northwest was held at the New Washington Hotel, Seattle, Wash., on the evening of September 21.

About 275 men, representing practically all the industrial developments of the Northwest, attended. Among this number were representatives of thirty-five shipbuilding companies in the states of Washington and Oregon, and a portion of British Columbia, which companies had on hand at the time contracts aggregating about $30,000,000.

The setting of the spacious dining-room was extremely unique, the entire decorating scheme being in harmony with the event. On each table was a miniature sailing vessel, while on the speakers' table rested a large model of a cargo steamer surrounded by navigating instruments. A large ship's lantern was hung from every chandelier, and at the far end of the room a lighthouse flashed alternately its red and white signals. The remainder of the room was decorated with buoys, oars, fish nets, etc., while the waiters in attendance were garbed in the attire of seamen.

Mr. William Pigott, president of the Manufacturers' Association, was toastmaster of the evening. His introductory remarks showed how the latent spirit of the Northwest had suddenly awakened and grasped the opportunity of industrial development and was now striving to make use of all the possibilities available. Mr. Kenneth C. Kerr, editor of the *Railway and Marine News*, outlined in part the status of shipbuilding in the Northwest and the representative valuation incurred thereby. President Henry Suzzallo, of the University of Washington, pointed to the fact that if this new industrial development was to be successfully carried through, it was imperative that the Federal Government must first aid and not restrain the initiative of the men who are eagerly working for the betterment of our merchant marine. This point was also emphasized by Mr. D. E. Skinner, president of the Skinner & Eddy Corporation, who also made mention of the fact that there is no future for the American merchant marine with the laws we now have, and that therefore people should not be too sanguine as to the future of shipbuilding in this country after the war. Mr. Will H. Parry, member of the Federal Trade Commission, gave a short but interesting historical synopsis of shipbuilding in the Northwest, which was pictured by lantern slides. Moving pictures of the launching of the *Niels Nielson* that afternoon concluded the event.

PERSONAL

Samuel P. Goman, formerly superintendent of the Harlan & Hollingsworth Corporation, Wilmington, Del., is now a superintendent of the Sun Shipbuilding Company, Chester, Pa.

W. M. Hanna, formerly trial engineer at the Union Iron Works, San Francisco, Cal., has been appointed port engineer of the Admiral Line, with headquarters in San Francisco. Mr. Hanna has served as chief engineer of the fast turbine steamers *Yale* and *Harvard*.

W. Freeland Dalzell, president of the Dalzell Towing & Transport Line, New York, has been appointed a member of the executive committee of the National Board of Steam Navigation.

J. W. Isherwood, of London, inventor of the Lidgerwood system of longitudinal framing for ships, has offered, through an English marine publication, a prize of $2,500 for the next airman who brings down a Zeppelin on British soil.

Charles I. Gibbs, general superintendent of the Ward Steamship Line, died recently at his home in Brooklyn, aged 53. Mr. Gibbs was in the employ of the Ward Steamship Company for thirty years.

Col. Robert C. McKinney, chairman of the board of directors of the Niles-Bement-Pond Company, New York, died at his home at Belle Haven, Conn., on October 3, aged 65 years.

Capt. Thomas S. Marvel, founder of the former Marvel Shipyard, Newburgh, N. Y., where the Morgan yacht *Corsair* and the Hudson River steamers *Hendrik Hudson, Trojan* and *Rensselaer* were built, died in Newburgh on October 25, aged 82.

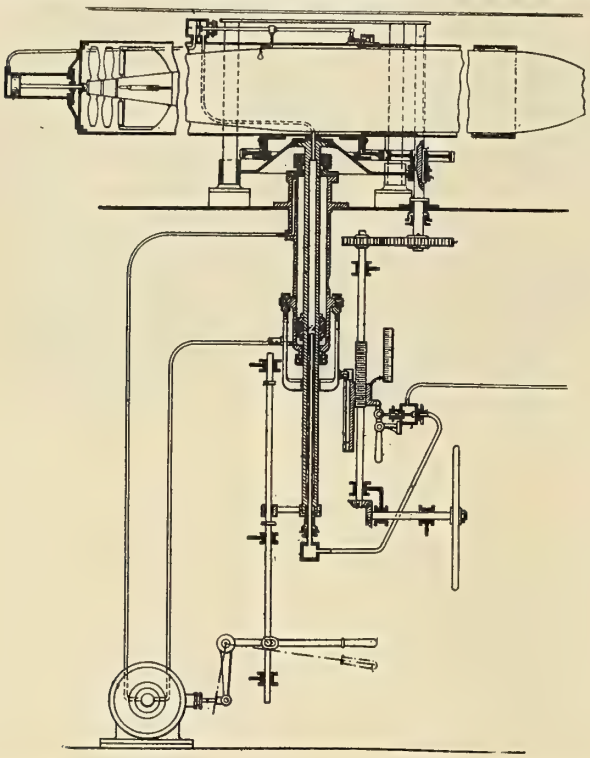
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,166,940. TORPEDO LAUNCHING APPARATUS FOR SUBMARINE VESSELS. EUGENE SCHNEIDER, OF LE CREUZOT, FRANCE.

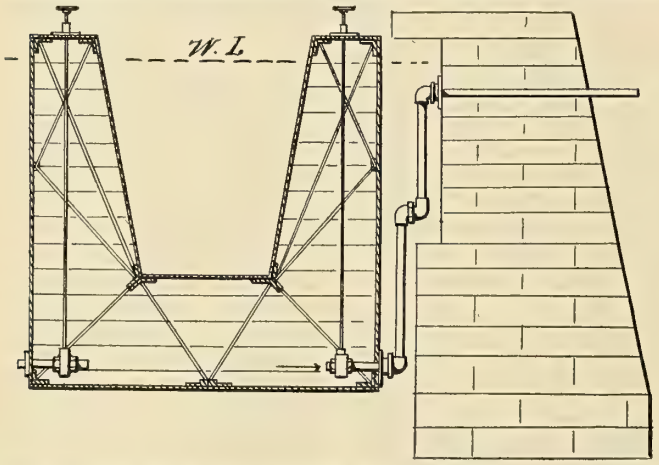
Claim 7.—In a submarine vessel, a torpedo compartment having therein a movable torpedo support, guiding members for said support, a torpedo carrying frame pivoted on said support, a motor outside said



compartment for moving said support clear of the vessel superstructure or deck, training mechanism released by a predetermined movement of said frame for rotating the latter into launching position, and means released by the operation of said training mechanism for launching a torpedo from said carrying frame. Twelve claims.

1,181,030. FLOATING DRY-DOCK. ROBERT O'NEILL, OF BUFFALO, N. Y.

Claim 1.—The combination with a hollow, floating dry dock having an intake pipe and a controlling valve therefor, of a discharge pipe, an outlet



pipe from the dry dock and swiveled pipe sections between said outlet pipe and the discharge pipe adapted to form a siphon. Two claims.

1,182,208. SUBMARINE-BOAT ATTACHMENT. WILLIAM H. RAMM, OF SEATTLE, WASH.

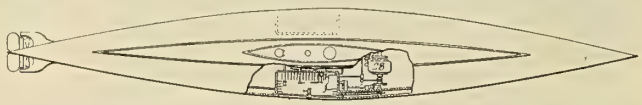
Claim 11.—A boat indicator comprising a float, a casting secured to the boat, tubes connected to the casting, a cable secured to the float and passing through the tubes and casting, a cylinder secured to the casting, a piston operating in the cylinder, and means carried by the piston and operating in the casting for severing the cable. Twenty-nine claims.
blades. Eight claims.

1,181,339. MINE AND SUBMARINE DESTROYER. WILLIAM H. NORFOLK, OF SAN PEDRO, CAL.

Claim 1.—A dirigible net comprising a submarine float structure, a series of supplemental float members, flexible means for connecting said float members and a submarine structure, means for propelling the submarine structure controllable from a remote point, and means for directing the movement of the submarine structure. Four claims.

1,183,163. ESCAPE APPARATUS FOR SUBMARINES. RENE BRUNET, OF NEW YORK, N. Y.

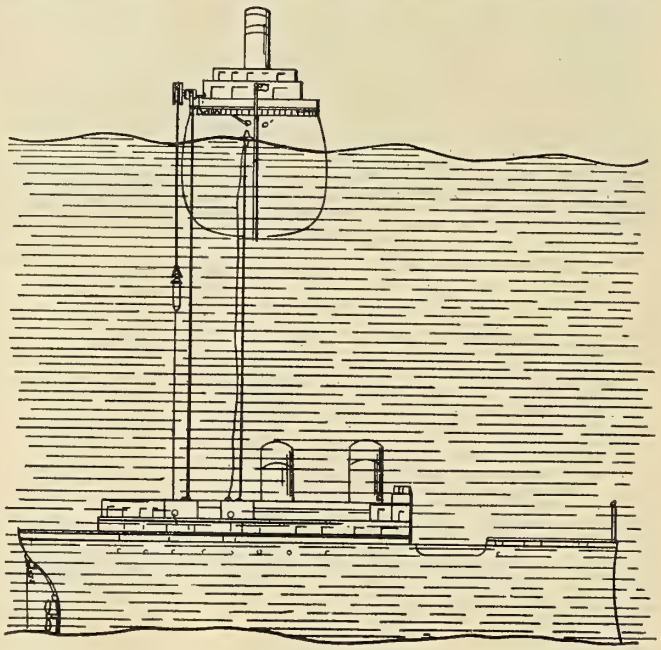
Claim 2.—In connection with the safety compartment of a submarine sea doors a plurality of power units for operating and closing said doors,



means for operatively connecting any one of said power units to said doors, and means for controlling said connecting means. Three claims.

1,183,078. MARINE LIFE-SAVING APPARATUS. JOSEF KONRAD, OF SPOKANE, WASH.

Claim 3.—In a marine life-saving apparatus, a ship, an air-tight habitable housing mounted on said ship, a human rescue container projected into and having an air-tight fit in said housing and provided with a grapple head projecting from said housing, a captive line connected with said container, means connected with said captive line and operable in



said housing for lowering said container into said housing, a buoy, a guiding line detachably connected with said buoy and connected with the grapple head of said container, and a hoisting cable having a grapple provided with means for guiding connection with said guiding line to guide said grapple into hoisting connection with said grapple head of said container. Eight claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn place, W. C., London.

4,704/15. HOLLOW HASTS, SPARS, STRUTS AND OAR-SHANKS OR THE LIKE. E. McGRUER, JR., OF BRAESIDE, CLYNDER, DUMBARTONSHIRE.

The invention relates to a method of bending wood from the flat board into tubes of circular, oval, or streamline-form transverse section. Where the edges meet end enclose the required section, a scarf-joint is worked and glued. In members made up with superposed laminar, glue is used all over the paying surfaces. The invention allows of masts, spars, struts, oar-shanks and the like being made tubular, in one, two, or more laminæ.

15,473/15. COLLAPSIBLE BOATS. A. A. THORNTON, OF QUALITY COURT, CHANCERY LANE, LONDON, W. C. (COMM. FROM F. HERZIK, OF 2002 PIERCE AVENUE, LOUIS MARTIN HERZIK, OF 502 MAIN STREET, AND A. J. VASICEK, OF 1008 TRAVIS STREET, ALL OF HOUSTON, COUNTY OF HARRIS, STATE OF TEXAS, U. S. A.)

This invention relates to boats which are adapted to be rolled up for storage or other purposes when collapsed, and to that end are formed of strips hinged together by being secured to a flexible covering, and arranged to lie parallel with each other when in collapsed position in order to permit of the rolling-up operation. The invention consists in the provision of an improved boat of the above-mentioned general character, having its sides and bottoms formed of strips hinged together and its ends formed of flexible material, whereby the boat is adapted to be rolled up, in combination with means for tending to hold the boat normally in open or operative position. The means preferably employed for accomplishing this consists in general of a spring or springs held in tension around the outer periphery of the boat, and in order to provide for the rolling up of the boat into its collapsed form to be easily accomplished means are provided for controlling the tension of these springs. Thus the tension can be relieved during the rolling-up operation and then so increased that immediately the boat is released it will at once adopt its open form. A further feature of the invention resides in the provision of means for securing the boat in collapsed position and means for releasing said securing means.

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U.S. PATENT OFFICE

A Boost for the American Merchant Marine

THE purchase of the fifteen million dollar plant of the New York Shipbuilding Company, Camden, N. J., by the American International Corporation and affiliated interests, which was ratified at a special meeting of the stockholders of the New York Shipbuilding Company on November 27, marks one of the most important steps in the present movement toward the upbuilding of the American merchant marine. The interests affiliated with the American International Corporation include the International Mercantile Marine Company, the Pacific Mail Steamship Company, the Grace Lines and other ocean transportation systems engaged in foreign trade. These interests comprise the largest steamship companies in the United States now engaged in foreign shipping, and the acquisition of one of the largest and best equipped shipyards in the country gives an exceptional opportunity for the co-ordination of shipbuilding and shipping operations which promises much for the future development of the American merchant marine.

The Day of Big Mergers at Hand

IN addition to the entrance of the American International Corporation into the shipbuilding field, negotiations of no less importance are in progress which may result in a merger of two of the largest shipyards in the country—the Newport News Shipbuilding and Dry Dock Company and the William Cramp & Sons Ship & Engine Building Company. Bearing in mind the extensive holdings of the Bethlehem Steel Company in the shipbuilding field, the numerous yards controlled by the American Shipbuilding Company on the Great Lakes and the shipbuilding and repair plants recently brought under the management of the Todd Shipbuilding Corporation, it is evident that the day of big mergers is at hand in the shipbuilding industry as elsewhere. That big combinations and centralized control and especially the interlocking of steel making, shipbuilding and shipping interests will prove beneficial to the shipbuilding industry from both financial and industrial standpoints cannot be doubted when the improvements and increased efficiency of production which invariably result are taken into account. If American shipbuilders are to make permanent the advantages which fate has literally thrust into their hands, the great resources of organization inherent in American methods of handling "big business" must be applied to the shipbuilding as well as to other industries.

Shipbuilding on the Great Lakes

THAT the prosperity in shipbuilding during the past year has not been confined solely to the coast yards is shown by the annual report of the American Shipbuilding Company of Cleveland recently issued. Due to the unprecedented demand for iron and steel products the season has been one of unusual activity for the Lake-carrying trade, and this has resulted in unusual demands upon the Lake shipbuilders, both for new tonnage and for a large amount of repair work. Further, the marked shortage of ocean tonnage has led shipbuilders on the Lakes, which hitherto have confined their operations almost wholly to the construction and repairing of Lake vessels, to undertake the building of ships for salt water service. A large number of Lake vessels have been sold and taken to the Atlantic coast to engage in coastwise and other deep sea service, so that the demand for Lake and sea-going vessels has steadily increased. The prospects for future business are in general better than ever before, although the prevailing high prices for shipbuilding materials and labor have limited the placing of contracts for Lake vessels to the actual necessities of shipping interests.

The Highest Powered Marine Diesel Engines

SO far as can be ascertained, the Diesel engines built by the Machinery Division of the New York Navy Yard for the naval collier *Maumee* are the highest powered marine Diesel engines installed on any vessel. The engines are of the two-cycle, single-acting type of 2,600 shaft horsepower each, built in accordance with original designs secured from the Machinen Fabrik Augsberg, Nurnberg, Germany, through the New London Ship & Engine Company, Groton, Conn. Each set of engines has six cylinders with a diameter of 25.2 inches and a stroke of 37.37 inches. The normal designed speed is 130 revolutions per minute.

It will be recalled that the hull of the collier *Maumee* was built at the Mare Island Navy Yard, San Francisco, Cal., and towed through the Panama Canal to the New York Navy Yard, a distance of 5,260 nautical miles, to receive her machinery. As designed the *Maumee* is a twin screw vessel of 14,500 tons displacement, 14 knots speed and 8,000 tons oil carrying capacity. The engines have now been installed on board the vessel, and on November 6 were given exhibition tests which were witnessed by many engineers. The vessel has since sailed for her sea trials and the performance of the engines at sea is awaited with much interest, as the opportunity is afforded for direct comparison with her sister ships fitted with reciprocating steam engines and turbo-electric propelling machinery.

Optimistic Outlook for Naval Architects

WHILE the annual meeting of the Society of Naval Architects and Marine Engineers, just held in New York, was not as well attended as was earnestly desired by those who have the best interests of the Society

at heart, nevertheless the Society gave every indication of a healthy growth, both in membership and in interest in the work before it. Throughout the meetings and the banquet which followed the professional sessions there was evident a most optimistic feeling for the future of the American shipbuilding industry and for the upbuildng of the American merchant marine. The conditions in the shipbuilding field throughout the world which have developed in the last two years, and which were so ably reviewed by the president of the Society in his annual address, give promise of a long-continded period of prosperity for American shipbuilders and a most hopeful situation as regards the growth of the American merchant marine.

Unfortunately, many of the shipbuilders were unable to attend the meetings, due to an important conference in Washington with the Navy Department regarding the contracts for the new naval construction authorized by the last Congress. Many others were also prevented from attending the meetings on account of the extraordinary rush of work which is now overwhelming naval architects, marine engineers and shipbuilders throughout the country. Due to the efforts of the secretary and other active members, however, over 100 new members were added to the Society during the meetings, and the Society will start the new year with a larger membership than ever before in its history. A glance at the list of new members will show that the Society has not only experienced a healthy growth in numbers, but that it has been materially strengthened by the high professional standing of the majority of the new members.

Millions of Dollars Wasted at Marine Terminals

For more than twenty-five years desultory efforts have been made to introduce freight-handling machinery in this country. During all these years the volume of freight has increased enormously; wages have gone up two or threefold, and the congestion at railway and marine terminals has become appalling, and yet nothing is done.

In the report of the Interstate Commerce Commission, published in 1912, it was shown that 900,000,000 tons of miscellaneous freight were handled during the previous year by the railroads of the United States. Leading terminal engineers who have thoroughly studied into the subject make the positive statement that from ten to twenty cents (0/5 to 0/10) a ton can be saved by handling freight at terminals with efficient mechanical appliances.

Here, then, is one direction in which the railroads of the country can save somewhere between $80,000,000 to $160,000,000 (£16,400,000 to £32,800,000) per year. As all freight is handled twice—once at the receiving end and again at the end of final delivery—the possibilities in saving would be about double these figures. And yet there is not one single railway freight station in the United States that is properly equipped with freight-handling machinery.

In the marine field it is estimated that 300,000,000 tons of miscellaneous freight are handled at marine terminals every year. As the conditions are practically the same in this field as in the railroad field, so far as economy in handling freight is concerned, there is a possible saving of from $30,000,000 to $60,000,000 (£6,150,000 to £12,300,000) annually. As this freight has to be received and delivered at marine terminals, the same as at railway terminals, the potential saving is twice the above amounts. And yet there is not a single marine terminal in any one of the hundreds of ports in the 5,000 miles of sea coast in the United States properly equipped with freight-handling machinery.

Over against this appalling situation is Hamburg, Germany, with about 700 traveling quay cranes, 200 or more winches and cranes in and on warehouses and a dozen or more heavy stationary cranes. The water front in Rouen, France, was increased from a capacity of 483 tons per linear yard to 1,121 tons by the introduction of machinery; in Marseilles the increase was from 665 tons per linear yard to 1,694 tons. On the 4,000 miles or so of Mississippi River navigable waters there is not a single landing properly equipped with freight-handling machinery, while on the river Rhine, with only 355 miles of navigable water, are 65 or more harbors with considerably over 400 warehouses mechanically equipped for handling freight, and 600 or more cranes and other appliances.

The railroad can make a possible saving of from $150,000,000 to $250,000,000 (£30,800,000 to £51,250,000) every year by using the proper kind of mechanical appliances to handle their freight, and the steamship and steamboat companies can save from $50,000,000 to $100,000,000 (£10,250,000 to £20,500,000) every year. In other words, our transportation companies are wasting between $200,000,000 and $350,000,000 (£41,000,000 and £71,750,000) of their stockholders' money every year by not installing efficient freight-handling appliances.

Any attempt on a large scale to bring about a change in the United States and introduce freight-handling machinery will be prohibitive in cost unless undertaken in a most comprehensive manner.

The men who have the handling of freight at railway and marine terminals have in nearly all instances grown up from the ranks. They are men of limited ideas and who cannot be persuaded to change from antiquated methods. Politics have a great deal to do with preventing a change, because in cases where hundreds of men are employed each one represents a vote. Boards of directors and others who have the handling of money hesitate to introduce new methods unless it is supported by the men who have the work in hand.

Scope of American Bureau of Shipping Widened by Acquisition of Great Lakes Register and Affiliation with British Corporation

One of the most important and far-reaching steps in the reorganization of the American Bureau of Shipping was outlined by Stevenson Taylor, president of the Bureau, at the annual banquet of the Society of Naval Architects and Marine Engineers, held at the Waldorf-Astoria Hotel on November 17, when he announced that the Great Lakes Register, which is affiliated with the Bureau Veritas for the survey and classification of vessels built on the Great Lakes for lake or ocean service, will henceforth be known as the Great Lakes Department of the American Bureau of Shipping, and furthermore, that an agreement had been entered into by the American Bureau of Shipping and the British Corporation for the survey and registry of shipping whereby these two societies will hereafter represent the same interests in their respective countries.

Mr. Taylor, who is president of the Society of Naval Architects and Marine Engineers, presided at the annual banquet of the society, and in his address described the new developments in the American Bureau of Shipping as follows:

"Thanks to the efforts of Judge Harvey D. Goulder and the interested patriotic vessel owners of the Great Lakes,

the *Great Lakes Register,* so well and favorably known for its work on the Great Lakes, has joined the American Bureau of Shipping and will hereafter be known as the Great Lakes Department of the Bureau, with Horatio N. Herriman the manager, and his corps of surveyors and assistants just as they have been, serving faithfully in the future as they have in the past. Hereafter, therefore, the judgment and experience of both corporations will be in unison to make classifications and surveys on the Great Lakes of the best character entitled to the confidence of all concerned in that important service.

"Believing that for trans-oceanic service all matters pertaining to construction should be governed by international regulations, the United States asked for an international conference on the subject of safety of life at sea. Such a conference was called to meet in London in November, 1913. This conference was attended by delegates from nearly every maritime nation in the world, and those appointed by the United States performed royal service in behalf of the cause, assisting materially in determining the convention, which was finally adopted and signed unanimously by the delegates from all nations. That it failed to be formally approved is another story not necessary for us to discuss at this time. Suffice it to say, the principle for which the conference was called remains the same to-day as in 1913, namely, that the construction of ships for trans-oceanic service should be so determined that in truth it shall be international.

"The American Bureau of Shipping fully realizes this need. It recognizes the valuable work done by other countries and their classification societies. It is therefore a pleasure to announce that in the Great Lakes service the arrangement made years ago between the Great Lakes Register and the admirable Bureau Veritas will be continued and probably extended.

"More, the American Bureau of Shipping determined that in such matters its action should be as near international as it could be made, and that as quickly as possible. For this purpose it sent Chief Surveyor McClelland abroad and there has been received cable advices that the American Bureau is at agreement with the British Corporation for the survey and registry of shipping, an agreement which gives the Bureau the full advantage of the practical experience and technical knowledge of that most progressive society, which during its twenty-six years has been recognized as leading the development of shipbuilding.

"The new rules of the Bureau will be based on the revised rules of the Corporation, and they will embody the most modern systems of building, with such scientific, accurate methods and such flexibility of application as will make them peculiarly adaptable to American ideals.

"The joint arrangement is particularly satisfactory because it ensures harmonious action and an interchange of ideas advantageous to owners and builders on both sides of the Atlantic without interfering with the independence and national character of either society.

"The arrangement immediately removes all difficulties in regard to international load lines for American classed ships, and will be of great advantage in helping our legislation when load lines are adopted here, as they must be.

"The Bureau will act for the corporation in America and vice versa. The classifications will be in effect interchangeable. Dual classifications will be obtainable at a little more than cost of single classification. Surely, development on such lines will be real international classification in its best form. Owners will now fully realize that no longer need they feel it to be necessary to have the classification of any particular foreign society to obtain full insurance here or abroad."

Lloyd's Annual Report

In few industries has the effect of the war been more widespread and far-reaching than in the domain of shipping. The disappearance from the high seas of the merchant fleets of Germany and Austria-Hungary, and the continued losses of allied and neutral shipping, combined with the enormous demands which the war has made upon the available tonnage, produced a shortage which has stimulated the building of ships in every country free to engage in ship construction. In the United Kingdom merchant shipbuilding is still seriously restricted by the necessity for the production of war vessels of various kinds; and, although there has recently been some acceleration in the rate of progress in the construction of vessels, the output remains far below that of normal times. In neutral countries, and particularly in the United States, every effort has been, and is being, made, by means of the extension of existing plants and the creation of new establishments, to cope with the increasing demand for tonnage. That a large measure of success has attended these efforts is evident from the fact that there is now being built under the inspection of Lloyd's Register of Shipping, with a view to classification, a larger amount of shipping than has ever been recorded in the history of the society, namely—620 vessels of 2,282,709 tons.

During the year under review the Lloyd's committee passed the plans of 742 vessels, representing 2,375,590 tons of shipping, to be built under the society's survey with a view to classification in Lloyd's Register, as compared with plans of 733 vessels, of 1,715,500 tons, for the previous twelve months. The committee assigned classes to 362 new vessels, of 790,209 tons, of which 356 were steamers, or motor vessels, of a tonnage of 789,688, and 6 were sailing vessels, of 521 tons. Of the total, 414,462 tons, or about 52½ percent, were built for the British Empire (United Kingdom 397,852 tons, Dominions 16,605 tons), and 375,747 tons, or about 47½ percent, for other countries.

American Committee Formed

To cope with the great development of the shipbuilding industry in America, an American committee of Lloyd's Register of Shipping has been established in New York, composed of leading underwriters, shipowners, shipbuilders and engineers, under the chairmanship of Mr. Alfred Gilbert Smith, president of the New York and Cuba Mail Steamship Company.

Among the most important changes in the society's staff in America during the year were the retirement of Mr. J. H. Mancor, for many years principal surveyor for the United States and Canada, and the resignation of Mr. Robert Haig, principal surveyor at Philadelphia, who has been elected president of the Robert Wetherill Engineering Company, Philadelphia, and a director of the newly formed Sun Shipbuilding Company. Mr. James French, principal surveyor at Glasgow, was appointed chief surveyor for the United States and Canada and technical adviser to the American committee; Mr. H. J. Cox, of the chief ship surveyor's staff in London, was appointed as assistant to Mr. French; Mr. E. M. Salmon, of the chief engineer surveyor's staff, was appointed principal engineer surveyor at New York; Mr. R. P. Hutchinson was appointed secretary to the American committee, and Mr. O. Narbeth, senior ship surveyor at Philadelphia, succeeding Mr. Haig as principal surveyor at that port.

Load Line Committee

The load line committee, in its report, points out that the means of closing openings is of vital importance, and proposes rules for machinery casings and for openings in

weather decks and sides of vessels, which are considered to be a necessary amplification of the present regulations. It is recommended that these particular proposals should be incorporated in the existing Rules for Freeboard.

The new freeboard rules proposed by the load line committee, which were framed with an endeavor to secure accuracy, simplicity and directness of application, make two main departures from present regulations with the object of providing, first, a means of assessing the freeboard allowance to be given for superstructures in a manner which will be equitable for all types of vessels, and, second, a standard of strength which could be applied internationally to ascertain whether the strength of a vessel is sufficient for the geometric draft which could otherwise be assigned.

During the year 1915-16 freeboards were assigned to 309 vessels, which bring the total number of assignments by the committee of Lloyd's Register under the Merchant Shipping Act, 1894, up to 17,949.

Types of Vessels Classed

The tonnage classed by the society during the year includes 32 vessels of 156,975 tons, built upon the Isherwood system of longitudinal framing. Up to date there have been built, or are in course of construction upon this system, to the society's classification, over 470 of these vessels, totaling 2,650,000 tons.

The number of vessels intended to carry oil bulk which have been classed by the society during the year under review is 14, of 77,167 tons. The total number of such vessels at present classed in Lloyd's Register Book is 301, of 1,380,235 tons gross. Vessels fitted for burning oil fuel holding classes assigned by the committee number 269, of 1,259,714 tons.

Owing to the increasing demands made for oil in this country many proposals to supplement the supply by converting ordinary cargo steamers into oil carriers have been dealt with by the committee. The society's classification has been assigned to vessels in which the oil is carried in large circular tanks built into the holds, and arrangements have been approved which will admit of fuel oil with a high flash point being carried in the double bottoms of cargo vessels, provided the construction is suitable for the purpose.

Revival of Wood Shipbuilding in America

Since the beginning of 1916 Lloyd's committee has considered proposals for the construction of several vessels to be built of wood, ranging from 100 feet to over 300 feet in length, the dimensions generally being similar to those of the four, five and six masted schooners built in the United States, the largest of which are 320 feet in length and 50 feet in breadth. It is proposed to build several of these wooden vessels on the Pacific Coast for use in the lumber trade to Australia. Steel reinforcements are introduced in the larger vessels at the keel and gunwale, and at the various decks, in order to give the necessary longitudinal strength to the structure. Plans have also been approved by the committee for several wooden vessels to be built on the Florida coast. In addition to the sail power, the vessels are fitted with single or twin screw oil engines for auxiliary use when necessary, donkey boilers being supplied for working windlasses and winches. Some of the larger boats will, however, be propelled by steam power alone.

Increasing Use of Geared Turbines

The increasing use of geared steam turbines in marine engineering is worthy of note. Nine vessels have been built to the society's classification during the past year, in which steam turbines have been fitted, three of these having Parsons geared turbines, and six having Curtis geared turbines.

At the present time there are 52 vessels in course of construction, with a view to being classed by Lloyd's, in which geared turbines will be fitted, viz.: 25 with Parsons single geared turbines and 27 with Curtis double reduction geared turbines.

Turbo-Electric Ship Propulsion

In the United Kingdom two vessels are being built to the society's classification in which the Ljungstrom turbo-electric propelling plant will be fitted, one a single-screw vessel, in which the power will be 1,500 shaft horsepower, and the second a twin-screw vessel with a total shaft horsepower of 5,400.

In the Ljungstrom turbine there are no stationary blades, the steam passes across two sets of blades which revolve at equal speed in opposite directions, so that the effect is similar to that which would occur with one set of blades stationary and the other set moving at twice the velocity. Each half of the turbine is directly coupled to its own alternator, producing a three-phase current of about 50 alternations per second with a voltage of about 800. The alternators of each set are electrically locked, ensuring exactly equal speed, and consequently equal power, on each rotating half of the turbine. In each vessel there will be two turbo alternator sets, so that the stoppage of one will not disable the vessel.

The two alternators of each set work in parallel. They have each only one pair of poles. They supply current to two motors each having five pairs of poles, which will therefore rotate at one-fifth the speed of the turbines. These motors are connected to pinions with spiral teeth which gear in the ordinary manner with a large gear wheel secured to the screw shaft. The combination of electrical and mechanical reduction gear will enable a speed of turbine of 3,600 revolutions per minute to rotate the screw at 76 revolutions per minute. The reversing of the screw is effected by the electrical motor, the steam turbines always running in one direction. Reduction of speed is effected down to about 80 percent of the full speed by varying the steam supply to the turbine. For slower speeds the regulation is effected by interposing resistances in the circuit.

Internal Combustion Engines

During the year under review seven vessels classed by Lloyd's have been fitted with Diesel engines. Three of these were built by Messrs. Harland & Wolff, Ltd., and engined by Messers. Burmeister & Wain, Glasgow, and the remainder were built and engined by Messrs. Burmeister & Wain, Copenhagen.

There are now 46 vessels holding the society's classification which are fitted with engines of this type, and, in addition, there are at present in course of construction under the society's survey over 30 sets of these engines. Twelve of the 46 vessels are equipped with "Werkspoor" four-cycle Diesel engines.

In addition to the foregoing, several vessels have been fitted with oil engines of other than the Diesel type, among which may be mentioned 11 fitted with hot-bulb engines made by Messrs. J. & C. G. Bolinder's Mekaniske Verkstads Aktiebolag, of Stockholm, and this type of engine is to be fitted in more than 30 vessels which are being built under the society's inspection.

Association of British Marine Oil Engine Manufacturers

During the year an association was formed by the British Marine Oil Engine Manufacturers for the promotion of the industry by the mutual interchange of ex-

perience, for standardizing designs as far as practicable and for carrying out such investigations and research work as may be necessary for the proper development of this type of machinery.

The association elected Mr. Milton, Lloyd's chief engineer surveyor, to act as chairman during the initiatory stages, and on the formation of the association Mr. Milton was nominated as an honorary member of the association.

Refrigerated Cargoes and Cold Stores

The number of vessels holding the society's certificate in respect of refrigerating machinery (Lloyd's RMC) is now 174, with a total insulated cargo-carrying capacity of about 37,500,000 cubic feet. The society's surveyors have held 1,017 surveys at loading and discharging ports on these vessels during the past twelve months.

The work of inspecting cold stores in various parts of the country is being continued, as is also the inspection of insulated barges trading on the River Thames.

Steel Testing

During the year 976,801 tons of ship and boiler steel were tested by the society's surveyors at home and abroad.

At the end of June there were 103 steel manufacturing firms in the United Kingdom, and 117 abroad, recognized by Lloyd's for the production of steel for use in the construction of vessels and machinery intended for classification in Lloyd's Register. Prior to any establishment receiving such recognition it is necessary that the works shall have been inspected and satisfactorily reported upon by the society's surveyors.

The total length of chain cable tested during the year at the Public Proving Houses in the United Kingdom, all of which are under the superintendence of the society, was 649,556 fathoms, in addition to a large quantity of miscellaneous chains and samples. The number of anchors tested was 12,686.

In addition to the above establishments, there are nine anchor and chain cable testing machines on the continent of Europe, twenty-three in the United States and two in Japan, recognized by the committee for the testing of anchors and chain cables. In these cases the necessary tests are required to be carried out in the presence of surveyors to the society.

Principal Surveyorship at Glasgow

Mr. James Montgomerie, B.Sc., who has been many years on the chief ship surveyor's staff, and has acted as principal ship surveyor for the United States, was elected for the important position of principal surveyor at Glasgow, in succession to Mr. French.

World Wide Demand for American Ships*

President of Naval Architects Society Summarizes Conditions Affecting American Shipbuilding—At Least Five Years of Prosperity Ahead

BY STEVENSON TAYLOR

THROUGH periods of alternate exaltation and depression, members of this society have retained their faith that some day there would arise such a demand for an American merchant marine that there would be no faltering in the future. It was not foreseen, however, that Europe would be almost entirely engaged in the fiercest war of history, bringing about unbelievable conditions, conditions with which our Government or citizens had nothing to do, for they are innocent of causing or participating in the frightful destruction of life and property that at present appalls the world. These conditions have brought to us the long-looked-for opportunity to build up our own marine commerce (as well as that of other neutral countries), and there is no reason for not availing ourselves to the utmost of this opportunity.

Statistics

This address promises to be mainly one of statistics. Many sources have been examined to determine the probable facts. It has been extremely difficult to obtain exact results, but a careful consideration of all of the sources warrants the figures given here in round numbers, and these figures, though perhaps not exact in themselves, do present existing conditions with sufficient accuracy to justify placing them on the record of your transactions.

Average Production of Shipyards

The year 1909, with a production of 1,602,057 tons, represents low tide, and the year 1913, with 3,332,882 tons, the high tide; therefore, the five-year period, 1910-1914, inclusive, fairly represents the average annual production of the shipyards of the world. This average was 2,740,000 tons gross.

	Tons
Of this amount the United Kingdom launched about 60 percent, or	1,650,000
Germany launched about 12 percent, or	330,000
United States coasts and Great Lakes (rivers not included) launched 9¼ percent, or	253,000
France launched 4½ percent, or	121,000
All other countries, including Great Britain's colonies and Canada, launched about 14 percent, or	385,000
	2,740,000

World's Tonnage

In the year ending June 30, 1915, the entire tonnage of the merchant vessels of the world amounted to 49,262,000 tons.

	Tons
The United Kingdom owned 43.5 percent, or	21,300,000
United States (excluding rivers and small lakes) owned about 12 percent, or	5,900,000
Germany owned 10 percent, or	5,000,000
France owned less than 5 percent, or	2,300,000

Taking the greatest tonnage of merchant vessels launched by any nation in any one year of all the years 1899 and including 1915, and combining same, we have a fair estimate of the capacity of the world's shipyards.

	Tons
These figures give a total capacity of	3,685,000
Of which the United Kingdom, colonies and Canadian lake ports launched 54 percent, or	1,984,000
United States Coasts and Great Lakes, 14.6 percent, or	540,000
Germany, 12.4 percent, or	465,000
All other countries, 19 percent, or	696,000

Conditions in 1914

In 1914 the building of merchant vessels was reduced by the European war to a minimum in all countries, the nations at war turning their attention almost entirely to the building of war vessels or munitions, while in the neutral nations it seemed as though marine, as well as all

* Annual address of President of Society of Naval Architects and Marine Engineers.

other merchant business, had come to an end; but in the last two years there has come a mighty change.

The destruction of some and the interning of the remaining merchant vessels of the Teutonic Allies; the commandeering of others by both sides, and the great destruction of merchant vessels of all nations, including neutrals, amounting now to 5,000,000 tons, has so reduced the number of available ocean ships that in order to transport the immense purchases of Europe and to furnish other ocean transportation there has arisen a demand never before seen for old, as well as new, ships, for anything indeed that could be used for oceanic service.

Present Conditions

The result has been that in the United States especially every vessel afloat, some extremely old, but every one available for the service, has greatly increased in value; every shipyard has been filled with orders for approximately two years, and many new yards have been established for the building of steel vessels; many old yards that built wood ships have been resuscitated, and many new yards also started for the building of wood vessels.

We are to-day, in our own country, in the midst of a shipbuilding boom unequaled in its history. It is to be remembered that command or freedom of the seas, depending on the point of view, is one of the very important causes of the war abroad, and that whatever may happen on land, at least Great Britain, Germany, France and Japan have the intention of being prepared, the first to hold and better if possible, its present superior position, and the others to increase the value of theirs, while the United States must now, if ever, regain its once formidable place on the seas of the world. There must naturally from these conditions come a great competition which will enlist all of the skill and efficiency of every nation having a merchant marine.

What is the condition to-day of the merchant fleets and what will be the tonnage requirements and the capacity of the world's shipyards in 1918? We have seen that the greatest production (the measure of capacity) of the world's yards up to 1915 was 3,687,000 tons. We estimate that in the year 1918 the capacity of the world's shipyards will be about as follows:

	Tons	Increase, Percent
United Kingdom, colonies and Canada	2,260,000	14
United States Coasts and Great Lakes	826,000	53
Germany	605,000	30
All other countries	809,000	16
Total	4,500,000	23½

The normal tonnage of the world this year amounts to about 50,000,000.

Of this there has been a tonnage:

Destroyed	5,000,000
Commandeered	12,000,000
Interned	4,400,000
Total withdrawn	21,400,000

Leaving available at present for regular service not more than 28,600,000 or 57.2 percent of the normal tonnage, which readily accounts for the present high freights and high values placed on old vessels.

	Tons
Presuming that peace will be restored by the end of 1917, we have present available tonnage as above	28,600,000
Commandeered and interned ships released	16,400,000
Probable production in year 1917	3,000,000
	48,000,000
Less future destruction, scrapping and depreciation	4,000,000
Leaving an available tonnage of	44,000,000
At the end of 1918, should peace be restored, there will certainly be required	55,000,000
Available at end of 1917, as above	44,000,000
Estimated construction, 1918	4,500,000
	48,000,000
Still leaving a tonnage deficit at end of 1918 of	6,500,000

From this it will be seen that high freights and high prices will continue and shipyards will be busy for some years to come, and it behooves all concerned, the Government, owners, builders and shippers to see that we obtain our share.

As to the increase in an American merchant marine flying the "Star Spangled Banner" the situation may be quite different, though we still hope not. At present the shipyards of the United States are building nearly 1,500,000 tons of steel and over 50,000 tons of wood vessels to be finished during the next two years.

Of these, at least 500,000 tons are for foreign account, and from reports recently received, this tonnage will be increased, so that about one-third of the vessels now contracted for in this country will fly foreign flags, mostly the flag of Norway.

At the present high freights, notwithstanding the high cost of building, owners can well afford to pay the difference between operating under the American flag and that of a foreign country, but possibly future conditions may change the special advantage we now possess.

Foreign Vessels Under American Registry

The European war has aided the merchant marine in the number of vessels registered as well as in the number contracted for in American yards. To September 26 last there were in all 196 foreign-built vessels of 642,802 tons admitted to American registry, but there were 261 American-built vessels of 151,676 tons sold to foreigners, leaving a balance of 491,126 tons, almost 10 percent increase in tonnage of American registry.

When the war ceases and the competition before referred to commences, it will be the privilege of the United States Government to aid ship owners to obtain their share of the freights then paid, be the same high or low.

The Shipping Board

What sort of protection, if any be necessary, shall be provided, and what changes in existing laws containing burdensome clauses shall be made, remain to be seen, and upon the lately authorized Shipping Board, with its extensive power, depends such recommendations to Congress as shall best be enacted.

Announcement has not yet been made of the personnel of this board, but we have no doubt that it will be of high character and that it will possess a general knowledge of the whole subject. Certainly, the Shipping Board will have an opportunity to afford great assistance and encouragement to those who desire to own and man ships to carry our flag over the seas and to do our share of the world's commerce without expending an undue amount of the $50,000,000 (£10,250,000) appropriated for its use.

A Government Shipping Company

In this connection it is interesting to note the establishment of the Belgian Shipping Company under the auspices of the Belgian Government, with a capital of 50,000,000 francs ($9,650,000), and of which all officers must be Belgian, born in Belgium; all stockholders must be Belgian, and no stockholder can be a partner or director of other companies of which the majority is not composed of Belgians, born in Belgium.

Marine Insurance

There has been recently one great change favorable to a firm establishment of an American merchant marine. For years the matter of marine insurance has been mostly left to foreign companies. As in other features of our business, we have been too busy with our inland matters to appreciate the worth of attention to marine insurance.

Only six months ago we were told that ship owners must go abroad for their insurance, and having had that habit for years it still was thought necessary. But we are

now in quite a different position, for insurance has been placed in this country for large amounts on single ships, and, wonder of wonders, insurance is being placed here for foreign owners.

United States Government Insurance

Here we should note the result of our own Government's operation of war risk insurance. From September 2, 1914, to July 31, 1916, the United States Government issued 1,539 policies, insuring $138,392,389 (£28,400,000) on American non-contraband cargoes, for which it received $2,904,886 (£600,000), with net losses amounting to $712,578 (£146,000), making a gross profit of $2,192,384 (£450,000). Deducting salaries and operating expenses, $32,982 (£6,750), leaves on policies issued during twenty-two months a net profit of $2,159,416 (£442,500).

Perhaps the Government cost did not cover all of the charges to which private insurance companies would be subject, nevertheless the experience warrants the careful attention of insurers as well as insured.

Nativity of Crews

One of the grave questions that arises in consideration of the American merchant marine is the one concerning crews. We do not suppose that at any time in the past crews of American ships were all native born, but it is quite certain that for a good many years the number of native born Americans serving on ships has gradually been decreasing. In 1909 about half of the crews on American ships were natives of the United States, while last year the proportion was reduced to 43 percent. We believe that there still remains something of the romance of the sea and its sailing ships, and given a world-wide trade our ships with power or without will attract more and more of our natives to service on board. We also have the alternative, the employment of those of foreign birth who will become our citizens. Here, as in other industries, the kind of immigration matters greatly. Our laws covering the question of physical and mental fitness must be strictly enforced. It would then seem that our American ships would be attractive to the best of sailors of whatever birth.

Committees on Fire Resistance and Bulkheads and Load Lines

As to your own direct interest as naval architects, two recent movements deserve especial mention. It is to the credit of Hon. William C. Redfield, Secretary of the Department of Commerce, that he called into service naval architects, shipbuilders, owners and operators to aid by conferences in the solving of two very important questions relating to vessels.

The first conference, held last May, on the subject of reducing the fire risk resulted in the testing by the United States Board of Standards of all sorts of materials that may render construction of vessels fireproof or nearly so. When these tests shall have been completed the competent committee appointed will report its recommendations.

The second conference, held last September, discussed the subject of subdivision of ships by bulkheads, and the equally important subject of assignment of load lines above which ships must not be loaded.

These subjects were referred to a committee of nine, seven of whom happen to be members of this society. It is needless to say that this committee, composed of naval architects, builders, owners and the president of the classification society, American Bureau of Shipping, will give the subject the most careful attention that it may be able when the time comes to give such information and advice to Government officials as they may require.

Subjects like the subdivision of ships by bulkheads, and assignment of load lines should be, as far as possible, treated as international.

For transoceanic service we should adopt the rules suggested by the Conference on Safety at Sea, held in London in 1913-1914. There still remains what appears more difficult of solution, our own Atlantic Coastwise, Pacific Coastwise and Great Lakes services, each of which brings problems of its own requiring the utmost careful consideration.

The Future

So far as shipbuilding is concerned, the figures already given for merchant vessels now being constructed and to be hereafter built prove that we are on the eve of great prosperity.

Make from the statistics herein given your own analysis. Mine is to the effect that there is before us a prosperous period of at least five years in which we can improve our facilities and methods so much that there will be no question of our shipyard efficiency and ability to meet competition, provided that our Government and Shipping Board really reason together face to face with our shipowners, shipbuilders and shippers, and determine to adopt the best policy to advance that most necessary and beneficial feature of our industries, an American merchant marine. Let there be no more periods when our grain and produce cannot be delivered for want of American ships, or times when any foreign government shall say what non-contraband goods can or cannot be shipped from our own ports.

Only the merchant marine service has thus far been considered, but the navy must not be forgotten. Add to the merchant ships which must be built in our yards the proposed increase in the navy, for which sixty-six ships of various classes are soon to be contracted for, at an estimated expenditure of $185,560,000 (£38,000,000), with armor, armament or navy ammunition, for which $66,595,000 (£13,650,000) more is required. Consider that included in this appropriation are the new battle cruisers designed by members of this society. The design of these battle cruisers is the most wonderful of all steps in the progress of designing skill, for in these ships are massed unprecedented power and unequaled speed and means of offense.

These facts are enough to fire your enthusiasm, but if you have listened with fair attention you have noted that there has been no indulgence in heroics. I trust, however, that you will have observed an underlying note of absolute faith in the future position and prosperity of our country, which must also carry with it the prosperity of those who build, own, operate and use our ships.

I see no chance of failure in the future. We need men, but they will come from the warring nations, tired of their systems of government and rejoicing to become American citizens. Men, too, will be raised to find their opportunity in the steadily alive shipyards of the future.

Our nation will again be a great maritime nation, holding its own among the other great nations of the earth. To feel otherwise would be a confession that our great Republic—now 141 years old—is a failure in self-government, enterprise, industry, efficiency and foresight, an appalling failure in those qualities that make men and great nations. This surely cannot be—it must not be.

Institution of Naval Architects.—The next annual meetings of the Institution of Naval Architects will be held in London on March 28, 1917.

Motor Boat Show.—The thirteenth annual Motor Boat Show will be held in Grand Central Palace, New York city, January 27 to February 3, 1917.

MOTOR YACHT GEORGIANA III PROPELLED BY SOUTHWARK-HARRIS DIESEL TYPE ENGINE

Built by Harlan & Hollingsworth Corporation, Wilmington, Del.

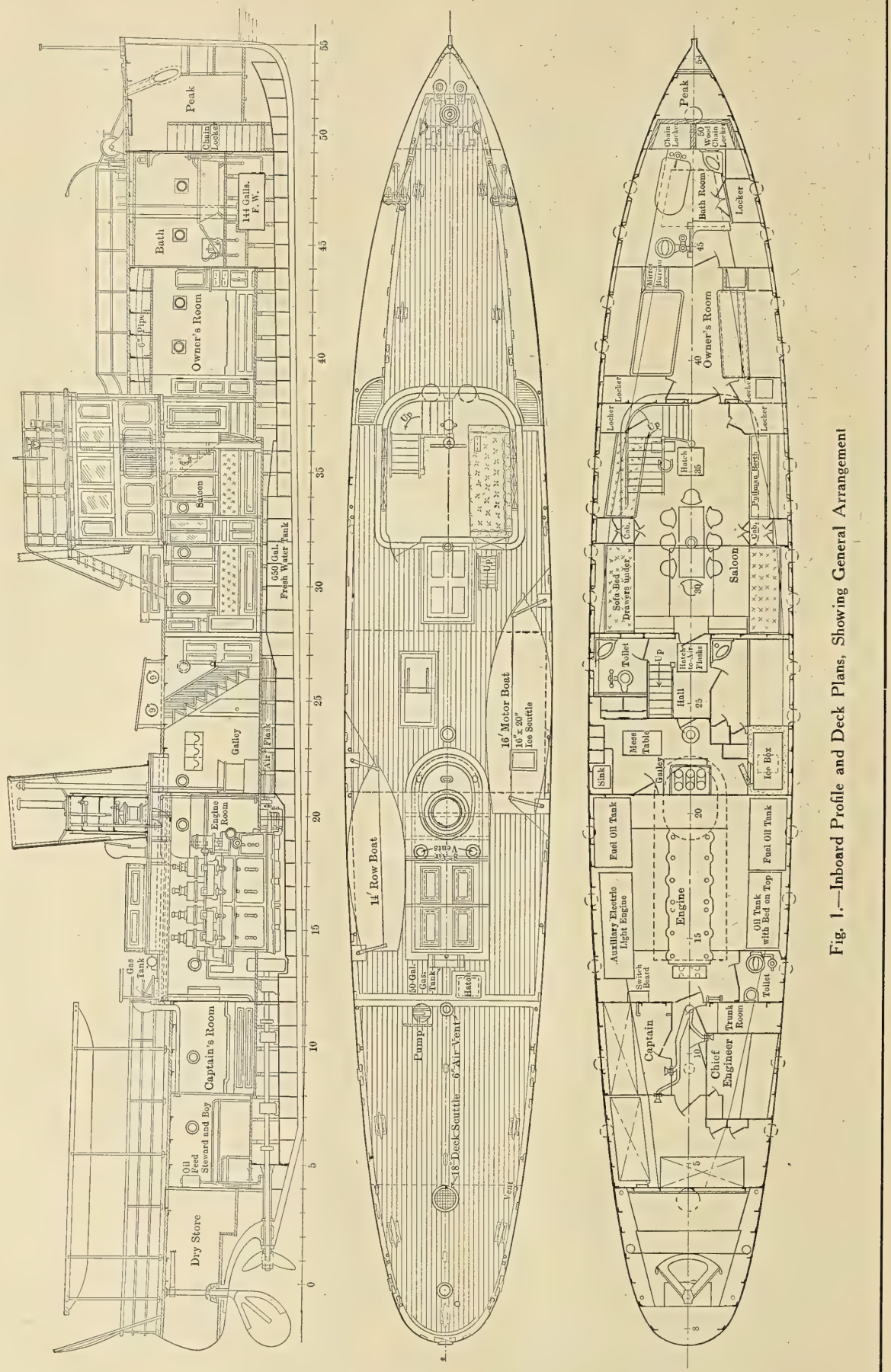


Fig. 1.—Inboard Profile and Deck Plans, Showing General Arrangement

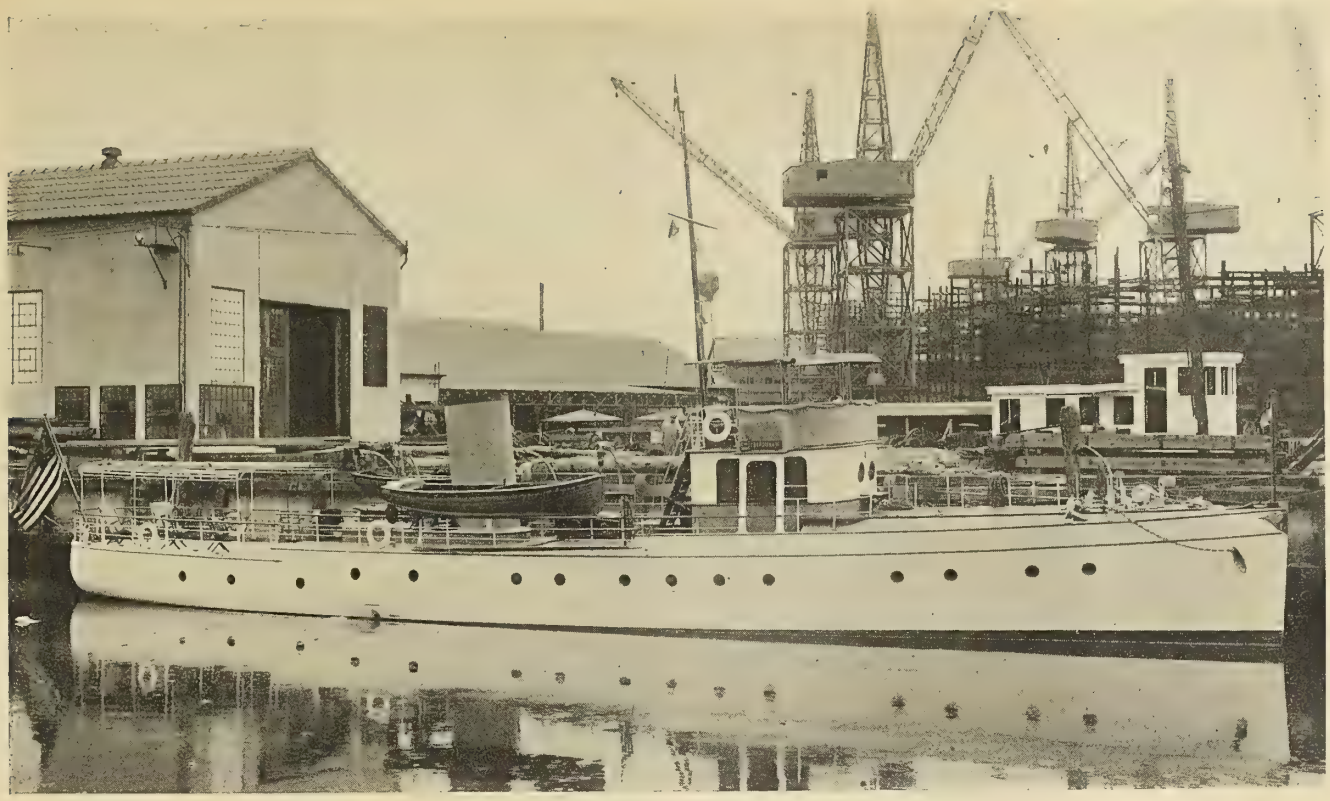


Fig. 2.—Motor Yacht Georgiana III at Builders' Fitting Out Dock

Diesel Engined Yacht Georgiana III

THE motor yacht *Georgiana III*, recently built by the Harlan & Hollingsworth Corporation, Wilmington, Del., for Mr. William Griscom Coxe, president of the company, is unique in many respects, embodying the owner's ideas of maximum strength and safety with minimum of ballast to obtain all necessary desiratum as to speed, stability, comfort, etc. The yacht was designed by her owner and Mr. A. M. Main, naval architect for the builders, and is propelled by a Southwark-Harris, Diesel type oil engine of 240 indicated horsepower. Her principal dimensions are as follows:

Length over all	95 feet 2½ inches
Length between perpendiculars	90 feet 0 inches
Beam, molded	15 feet 0 inches
Beam, extreme	15 feet 2 inches
Depth, molded above top keel	9 feet 4 inches
Draft	5 feet 6 inches
Gross custom house tonnage	82 tons
Net custom house tonnage	44 tons

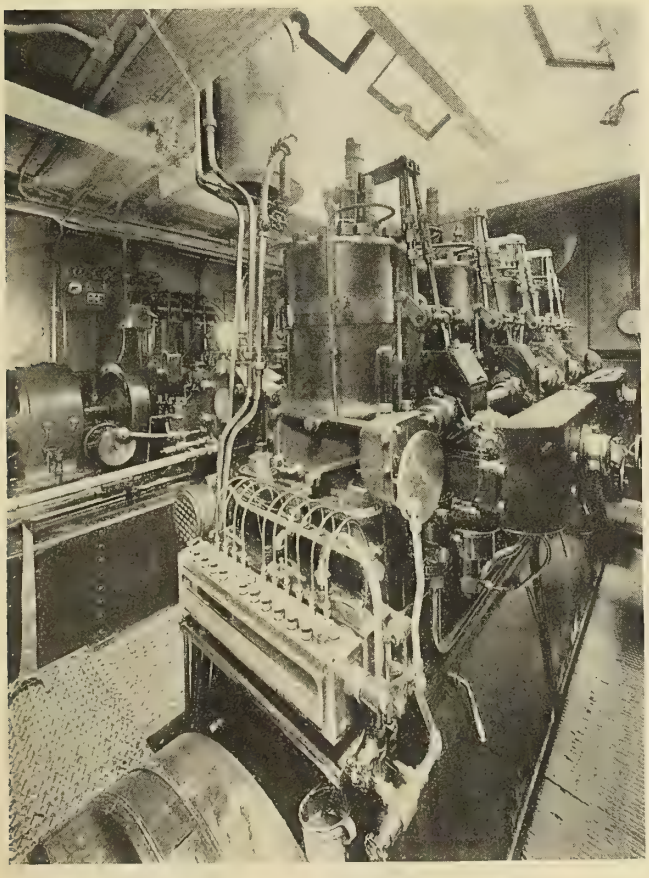


Fig. 3.—Engine Room

The vessel has a center vertical through plate keel, ½ inch thick under the machinery, with side bars. At the ends this keel becomes merged into a bar type keel, 5 inches by ⅞ inch, and steel bar stem rabbeted and sharpened on fore edge, the stern post being a steel casting taking the boss of the single shaft and rudder post.

For a portion of her length a double bottom is constructed on the cellular principle to carry fresh water. The frames are of bulb angle, 3 inches by 2 inches by 3.6 pounds, spaced 20 inches centers. The hull is divided into seven watertight compartments by six steel bulkheads. Four of the bulkheads are fitted with watertight doors of similar type to those on torpedo boats. The peak bulkheads are not pierced by doors. The two side keelsons are composed of double bulb angles fitted back to back. Beams are of bulb angles, 3 inches by 1¾ inches by 3.25 pounds, fitted to every frame. On the forecastle the deck beams are of angle section. The floor plates, garboard strakes of the shell and sheer strakes are of 10-pound plate, the thinnest shell plating being about 7 pounds. The upper shell is built flush and smooth, having straps fitted at the edges and butts; below the water the edges are overlapped.

The upper deck, quarter deck and forecastle deck are

plated with steel stringers and tie plates lightened by holes. The skylight over the engine room and the deck house are of steel. Steel bulkheads and steel decks enclose the galley and obviate the spread of fire originating there.

The forecastle, bridge, upper and quarter decks have mahogany margin planks and narrow white pine planking fastened from below with brass screws and all payed with marine glue.

The general arrangement of the vessel, which embodies the owner's ideas is almost identical to that of the *Georgiana II.* The old yacht was 70 feet over all length, and in the new yacht the owner's quarters are more spacious, while an additional room and improved galley and storeroom arrangement was obtained. The crew's quarters are also very much better.

Fig. 1 shows the layout and arrangement of the various decks.

Beginning forward, the fore peak, in which water ballast can be carried if desired, is piped to the bilge pumps, a locker being built in the peak for stowage of chain cable. In the owner's bath room the walls and ceiling are covered with sanitary "Like-tile" and the floor with inlaid linoleum. The room is lighted and ventilated by four side lights or ports, and has a small sirocco suction fan for discharging vitiated air.

The owner's bedroom has neatly paneled walls and ceiling finished in white enamel. The floor is carpeted, the color of the carpet and draperies being cobalt blue. This room has four side lights, or air ports, and a safe is fitted into one of the four lockers.

The main saloon is paneled in quartered oak, all furniture and beams overhead being in oak. The ceiling panels are of ply board, painted cream white. The upholstery and wall panels are of English tapestry, which, with the carpet, is of design and color harmonizing with the brown oak. Light and ventilation are provided for by eight 9-inch side lights, or air ports, and a large overhead skylight. The stairway at the forward end lands in the deck cabin, which forms the main entrance to the owner's quarters. This main saloon has a steel watertight bulkhead at either end.

Abaft the saloon is a hallway with stairway to a companion on the upper deck. Opening off the hallway is a guests' toilet finished in "Like-tile," the floor being covered with interlocking tile, as in the hall. On the starboard side of the hall is a children's room finished in enamel white and with carpet and draperies like those in the owner's room.

The galley is separated from living quarters by a metal bulkhead. The floor of the galley is covered with asbestolith, while all dish racks and lockers are of metal. The sink is provided with a pump, which can draw from the sea or fresh water from main tank. The range is a Shipmate, with hot water back and hot water tank and sits on a metal coal box. The ice box is built into the vessel, efficiently insulated, the ice being put into the box through a watertight scuttle on upper deck. The galley is ventilated by portion of main stack, which extends over the range, and is lighted by two sidelights, or air ports, and a deck light.

The deck cabin is paneled full height in white mahogany and has seven large plate glass drop windows with two 15-inch diameter sidelights in front. A large built-in davenport, with seat, back and arms, upholstered in Spanish leather, a card table and movable chairs, complete the furniture of this room. Pullman shades, mosquito screens and storm shutters are provided for the windows. The white mahogany is finished natural color, the carpets, upholstery and window shades being green.

The deck house is of steel, but the upper part above the window rail outside is paneled in mahogany. The saloon skylight and companionway are of mahogany. The top of deck house is utilized for a navigating bridge and is extended at the forward end to the sides of the vessel, giving the navigator a view along the full length of the yacht.

The engine room, located abaft the galley, is bounded by steel watertight bulkheads. Fuel oil tanks independent of the yacht's structure are fitted on each side of the engine room. A toilet for the crew's use is enclosed in metal bulkheads at the aft end of the engine room. The main engine foundations consist of fore and aft girders, which take the holding down bolts. These girders are connected to the shell of the yacht and to deep floor plates, making a rigid foundation. The engine driving the air compressor and electric generator are on one foundation and sit on one of the oil tanks, which is strengthened to suit.

The engine room is lighted and ventilated by the stack, six 9-inch sidelights, or air ports, and by a steel skylight having four rectangular sections, which are raised by rods, each section having rectangular wired glass for light. Two 8-inch copper cowl ventilators and a booby hatch are also provided.

The crew's quarters extend from the after bulkhead of the engine room to the after-peak bulkhead. In the after castle two metal beds are provided for the deck hands, also two lockers. A trunk room is also provided for in the after quarters.

The lazarette abaft the peak bulkhead is entered through a watertight brass deck scuttle. This space in the cruiser stern is commodious, and here are stowed the storage batteries, etc. The quarter blocks and quadrant, with tightening device for steering ropes, are located here, and are accessible.

The steering gear consists of a brass steering column with hardwood wheel operating the shaft, which, through gearing and pinion, drive a rack to which the steering wire ropes are attached. The ropes are carried under the deck to the quadrant in the lazarette.

Communication between the navigating bridge and engine room is by means of telegraph and speaking tube. The usual navigating instruments are installed. The compass is a 3-inch liquid in a brass-headed compensating binnacle on mahogany column of Hand's make. A Gray-Hawley whistle, operated by compressed air, and a Klaxon is also provided and located on the mast; also an 8-inch fog bell and searchlight are fitted on the mast and controlled from the bridge.

The mast carries a cross yard for flying signals. The windlass, made by the American Engineering Company, is a No. 3 Providence, and is equipped with elastic chain stoppers.

The equipment of the yacht consists of 105 fathoms 10/16 chain cable, two 240-yound anchors and kedge anchor, with all necessary ropes, running lights, signals, life preservers, fire hose, fire extinguishers, etc., required by law. She has a 14-foot tender or dingy and a 16-foot motor launch made by Luders Marine Construction Company, Stamford, Conn.

The pumping of bilge and peak tanks is performed by a bilge pump on an auxiliary engine and by a rotary hand pump attached to a manifold, from which pipes are led to the various bilges and tanks. A bilge pump is also attached to main engine. The rotary pump has a connection to the sea, also is used for fire or wash deck purposes.

The yacht is propelled by a Southwark-Harris valveless engine—Diesel principle—designed to indicate 240 horse-per minute. The engine has four cylinders, 9-inch diam-

eter, 13-inch stroke. The fuel used is crude or fuel oil. The engine is started from rest by compressed air, and when stone cold can be brought to full power in 10 seconds. This engine is directly reversible and can be put from "full ahead" to "full astern" in 5 seconds. It has been fully described in previous issues of this journal.

The engine on the *Georgiana III,* after the usual preliminary trials and adjustment, has given entire satisfaction and has run for a day at a stretch in rough weather without any more care than a steam engine would require. The oil tanks have a capacity of 1,070 gallons, and at a consumption of 8 gallons per hour when running at a speed of 15 miles per hour, give the yacht a cruising radius of almost 2,000 miles on one filling of tanks. The air bottle containers for compressed air, which is used for starting engine, forcing and vaporizing the fuel, blowing whistle, etc., have a capacity—without recharging—to enable the engine to be stopped and started fifty times.

The propeller is 4 feet diameter by 60 inches pitch.

The auxiliary machinery consists of a 12 to 16-horsepower Frisbie gasoline (petrol) motor, driving a direct-connected, 3-kilowatt electric generator, and also driving, from the same shaft extended forward, a 4½-inch by 5-inch air compressor and a bilge pump. The gasoline (petrol) for this motor is carried in a tank on deck, which also carries a supply for the motor launch. The lubricating tanks are carried high on the side of the yacht, and an oil fuel supply pressure tank is also carried high up on the side. The engine room is well arranged and practically no wood is visible except the seat and gage boards.

The telegraph receiver, speaking tubes and gages are on the forward bulkhead, near the starting wheel of the main engine. The yacht is lighted by electricity, the running lights being a combination of oil and electric. The searchlight fitted on the mast is a 9-inch General Electric. The switchboard is located at the aft end of the engine room, near the generator.

The *Georgiana III* has proved to be a very comfortable off-shore cruiser. She has roomy, clear decks, the quarter deck having ample space for chairs. The forecastle and bridge decks, due to the vessel's freeboard, are dry in any weather when the wind has a velocity less than a gale. When at rest her quarter deck is 4 feet 6 inches above the load waterline, the bridge deck 5 feet, the forecastle 8 feet 6 inches, and the navigating bridge 12 feet. She has been tested out in cruising between New York and Norfolk, Va., having encountered at times a gale of 40-mile velocity blowing against the tide and creating high seas. Her behavior in such conditions is reported as ideal, her motion being like that of a vessel under sail and her decks practically dry. Her owner and captain have the utmost confidence in her ability to go anywhere, as she is strongly built and can stand severe handling.

AWARD OF NAVAL CONTRACTS.—Contracts for the four battleships authorized by the last Congress will be evenly divided between the New York Shipbuilding Company and the Newport News Shipbuilding & Dry Dock Company. Contracts for the construction of 27 coast defense submarines and two 800-ton fleet submarines were awarded on November 29 to private shipbuilders. Eighteen of the coast defense and one fleet marine will be built by the Electric Boat Company; 6 coast defense and one fleet submarine by the Lake Torpedo Boat Company, and 3 coast defense submarines by the California Shipbuilding Company. A third fleet submarine will be built at the Portsmouth Navy Yard.

Rules for Ordering Rivets

BY WILLIAM M. KENNEDY

The following very simple rules—having been developed from practice—give excellent results in ordering rivets.

Order lengths for flush point rivets, countersinking done under Lloyd's rules.

To total thickness of plating add thickness of top plate plus ¼ inch for two-ply, for each additional ply add thickness plus additional ⅛ inch.

Example—Order rivets for driving flush points in a connection consisting of two 5/16 inch and one ⅜ inch plate, the latter being the top plate.

Thickness of three plates, 5/16 + 5/16 + ⅜	=	1 inch
Thickness of top plate	=	⅜ inch
Added length for two-ply	=	¼ inch
For one additional ply over two	=	⅛ inch
Length to order	=	1¾ inches

Ordered lengths for flush point rivets, countersinking done under United States Navy rules.

To total thickness of plating add thickness of top plate plus ⅛ inch for two-ply. For each additional ply add thickness of ply plus ⅛ inch. For excessive thickness ¼ inch should be added for each ply over two.

LLOYD'S COUNTERSINKING

"The countersink is to extend through the whole thickness of the plate when less than 14/20 inch thickness; when 14/20 inch or above the countersink is to extend through nine-tenths the thickness of the plate."

UNITED STATES NAVY COUNTERSINKING

"Holes for countersunk heads and points should extend through the plate or shape when the thickness of the metal is ¼ inch or less. Where the thickness is greater than ¼ inch the depth of the countersink will extend about 1/16 inch less than depth of standard rivet heads."

It will be seen from the countersinking rules that the thickness of the top plate determines the additional length of rivet required to fill countersink.

As all holes in ship work are not fair or accurately fitted, it becomes necessary to ream them; this increases the area to be filled by the rivet. The rule takes care of this condition. The rivet in a hole requiring no reaming or recountersinking will have a medium-sized chip to take off; the general run of the holes will require a very light chip be taken off rivets, while in the passable hole the rivet will just fill countersink. Holes that do not meet the last condition should be reamed to the next larger diameter.

When convex heads are required an additional ⅛ inch should be added for each ⅛ inch height of convex.

For snap or button head riveting a table will simplify the rule, which is as follows: For ⅜ inch diameter, two-ply of plating 1-inch stock in addition to thickness will be required to form head, for each and every increase of diameter or ply an addition of ⅛ inch in length plus thickness of plates will be required to form head.

Table for ordering snap or button head riveting, derived from the above rule, base being ⅜ inch diameter, two-ply of plating.

Diameter of Rivet. Inch	Two-Ply. Inches	Three-Ply. Inches	Four-Ply. Inches
⅜	1	1⅛	1¼
½	1⅛	1¼	1⅜
⅝	1¼	1⅜	1½
¾	1⅜	1½	1⅝
⅞	1½	1⅝	1¾
1	1⅝	1¾	1⅞

To thickness of plate add tabulated length which will fill hole and form head.

As in shipwork holes are punched or reamed ⅛ inch greater in diameter than the diameter of rivet, and as the

thickness of plating governs the diameter of rivets by all rules, it can be understood why the greater lengths are required to fill holes and form heads on rivets as they increase in diameter.

When the lengths of rivets work out as odd sixteenths, order to the next higher eighth.

For compression riveting add ⅛ inch to lengths given in the table.

When ordering countersunk head rivets add ⅛ inch to length, as countersunk head rivets are measured over all and it is impossible without counterboring—which is impracticable—to make heads finish flush. The aim is to have them slightly high, hence the additional ⅛ inch. Other types of head have no bearing on ordered length.

There should be no local conditions existing that would alter lengths required for standard riveting. The practice of using larger or ground down dies to utilize some size of rivets on hand cannot give best results. The rivets for countersunk work will work out as stated, if the countersinking is done according to rules and recountersunk when cut away in reaming.

With standard methods, standard machines and dies and standard method of work specified by registration societies and United States Government, there seems no logical reason why these rules will not work out satisfactorily for any yard.

Notes from the Model Basin*

Effect of Surface Condition on Efficiency of Propellers—Air Resistance of Ship's Model

BY NAVAL CONSTRUCTOR WILLIAM MC ENTEE, U. S. N.

DURING the last year at the United States Experimental Model Basin the press of routine work has been such as to prevent any original investigations which would require the use of the basin for any great time. There has been opportunity, however, to continue experiments relating to the part played by the frictional resistance of water in the resistance and propulsion of ships.

The results of the tests reported in my paper, "Variation in Frictional Resistance of Ships with Condition of Wetted Surface," read before the society last year, indicated the importance of the condition of wetted surface as affecting the resistance of a ship. As a natural extension of this investigation, an attempt has been made to ascertain the corresponding effect of surface condition on the efficiency of propellers.

The results as given in the present paper indicate that this is a matter of equal importance as affecting the economical operation of ships.

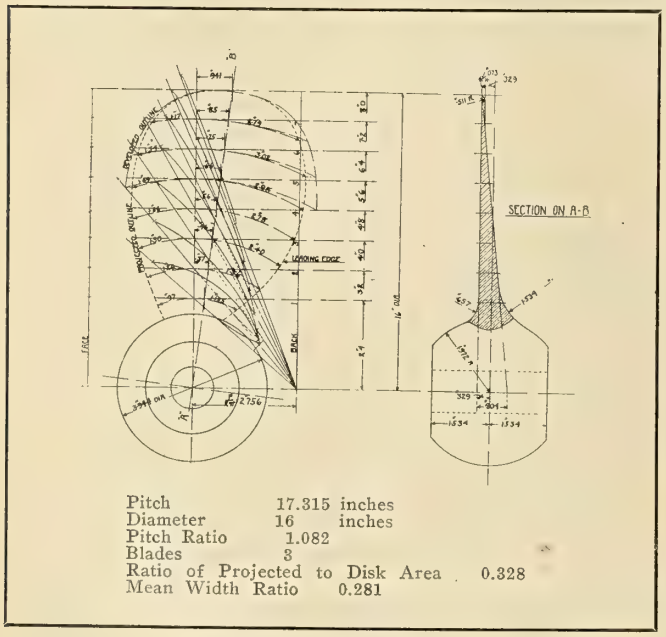


Fig. 1.—Model Propeller No. 285

Propellers used for naval work have customarily, especially on high-speed vessels, been carefully finished by machining the rear surface of the blades to a true helicoidal surface and finishing by hand the leading face so as to make the entire surface smooth and polished. In doing this, however, it seems that the object was as much to get blades which would have uniformity of pitch and balance as to get a smooth frictional surface. For merchant vessels propellers are commonly made with blades of cast iron or cast steel, and no finish is given except trimming off the rough places with a chisel or rough file.

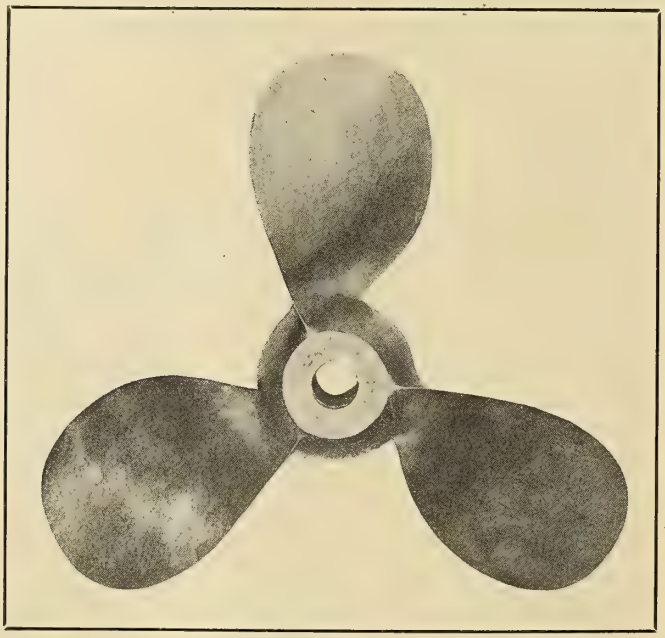


Fig. 2.—Model No. 285. Bronze—Smooth Finish

To ascertain what may be expected from the difference in naval and merchant practice, four 16-inch propellers, made as closely as possible to the dimensions shown in Fig. 1, were tested at a uniform speed of 5 knots. Two propellers were of bronze, one of cast iron and one of cast steel, and all were models of a propeller which has given excellent results in actual service on a battleship. The appearance of these models is shown in Figs. 2 to 5.

Propeller No. 285 was already on hand. It was ma-

* Paper presented before the Society of Naval Architects and Marine Engineers, New York, November 16.

PROPELLER MODELS USED FOR EXPERIMENTS

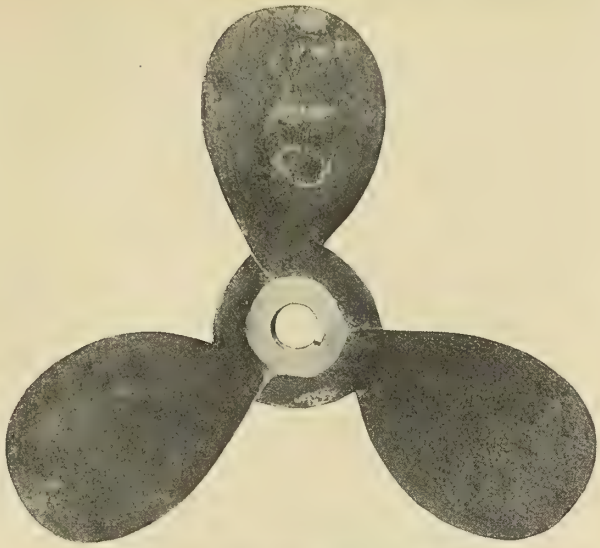


Fig. 3.—Model No. 310. Cast Bronze

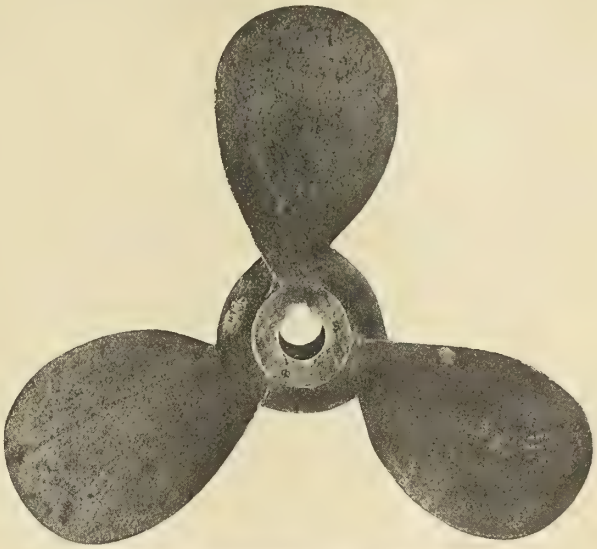


Fig. 4.—Model No. 309. Cast Steel

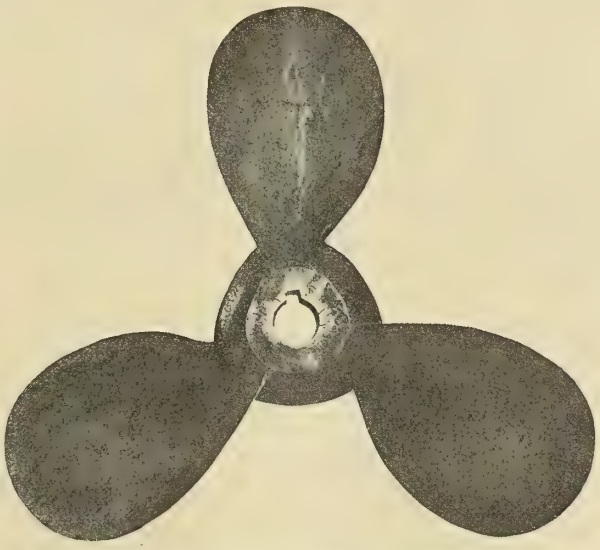


Fig 5.—Model No. 308. Cast Iron

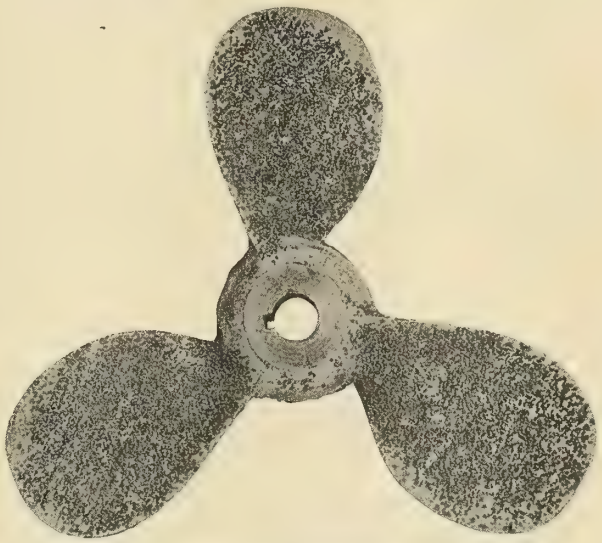


Fig. 6.—Model No. 285. Bronze—Smooth Finish and Cork Painted

chined to a true helicodal surface on the rear face of the blades, and finished by hand to a true surface of convex section on the leading face. The accuracy of finish was the same as that of the series of propeller models heretofore tested from time to time at the model basin. The three cast propellers were supplied through the courtesy of Mr. William Gatewood, naval architect of the Newport News Shipbuilding and Dry Dock Company. They were made from a separate pattern and were cast as nearly as possible to the finished dimensions of model No. 285.

The results of the tests are shown in Fig. 7, from which it will be seen that the effect of the rough surface of the models as cast is to reduce the maximum efficiency as compared with the smooth model from about 72 percent to about 63 percent.

When a vessel lies for even short periods in waters where fouling occurs rapidly there is frequently a considerable accumulation of barnacles and other sea growth on the propeller. In order to investigate the effect to be expected from the worst probable condition of propeller surface, propeller No. 285—that is, the bronze propeller with smooth finish—was varnished, and while the varnish was still soft there was applied a covering of granulated cork such as is ordinarily used in ship work for cork paint. The appearance of the smooth-finished model and of the same model covered with granulated cork is shown in Figs. 2 and 6. The results of the test are shown in Fig. 8.

From this it will be seen that the effect of the roughening of the surface is to reduce the maximum efficiency from about 72 percent to about 36 percent. If compared on the basis of the same thrust, the prejudicial effect of the rough surface will be even more pronounced.

Air Resistance of a Ship's Model

During the trials of the U. S. S. *Neptune* it was found that a considerable variation of power was required to maintain a given speed, depending on the direction and force of the wind. As the *Neptune* is a collier with a large number of coaling booms for rapid handling of coal, the top hamper presents a large area for the wind to act on, so an investigation of the air resistance seemed desirable.

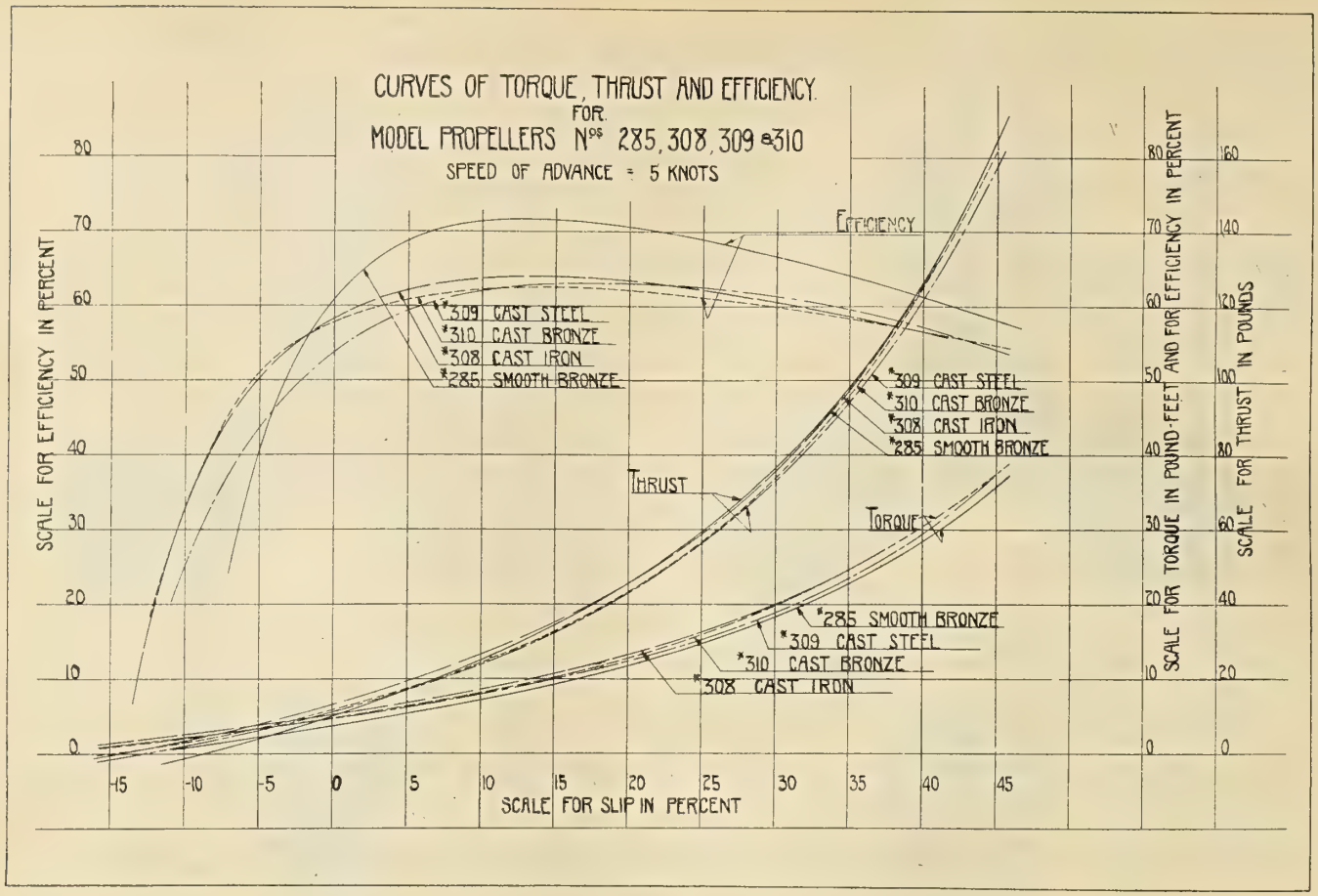

CURVES OF TORQUE, THRUST AND EFFICIENCY
FOR
MODEL PROPELLERS Nos 285, 308, 309 & 310
SPEED OF ADVANCE = 5 KNOTS
EFFICIENCY
*309 CAST STEEL
*310 CAST BRONZE
*308 CAST IRON
*285 SMOOTH BRONZE
THRUST
TORQUE
SCALE FOR EFFICIENCY IN PERCENT
SCALE FOR TORQUE IN POUND-FEET AND FOR EFFICIENCY IN PERCENT
SCALE FOR THRUST IN POUNDS
SCALE FOR SLIP IN PERCENT

Fig. 7

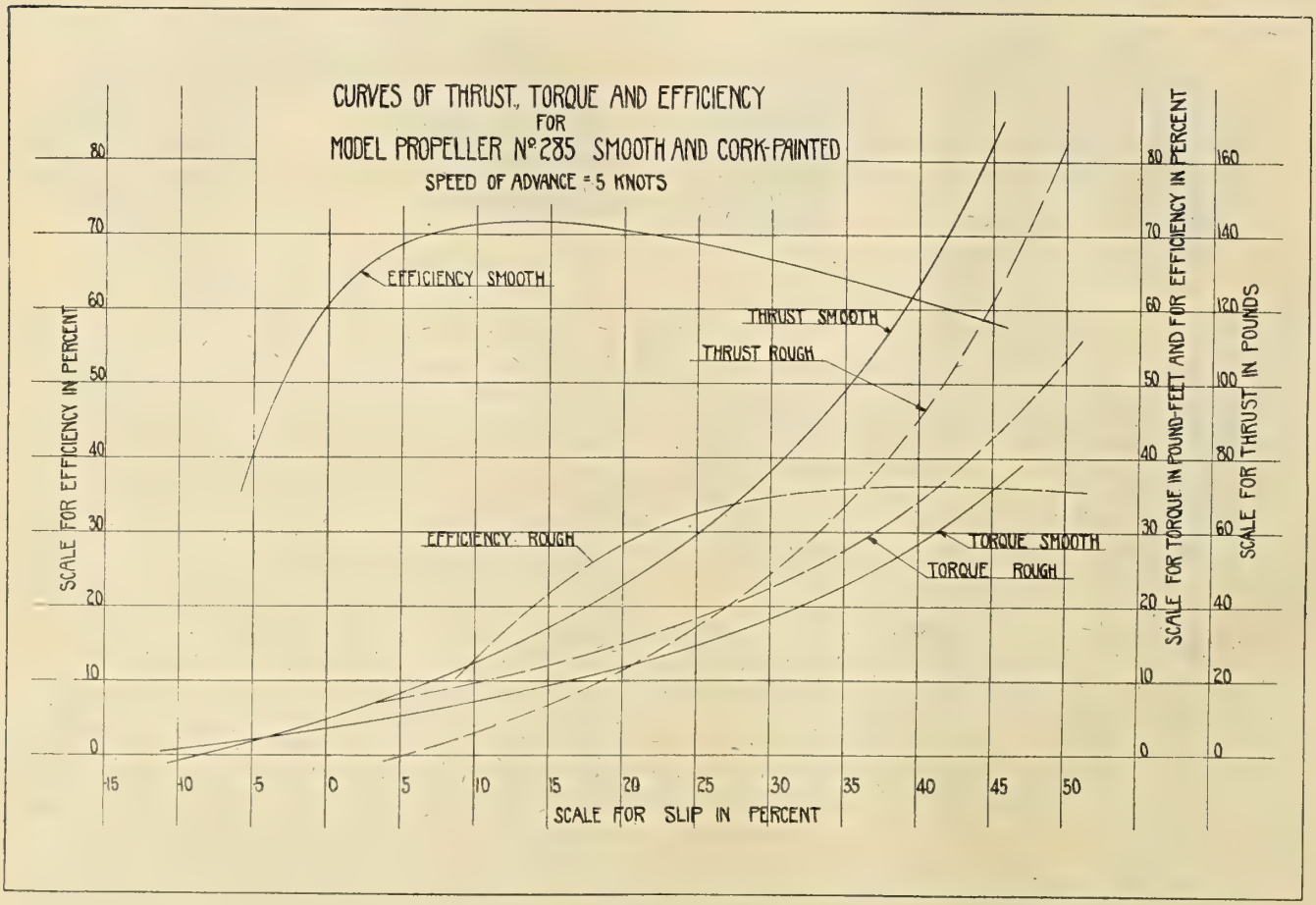

CURVES OF THRUST, TORQUE AND EFFICIENCY
FOR
MODEL PROPELLER N° 285 SMOOTH AND CORK-PAINTED
SPEED OF ADVANCE = 5 KNOTS
EFFICIENCY SMOOTH
THRUST SMOOTH
THRUST ROUGH
EFFICIENCY ROUGH
TORQUE SMOOTH
TORQUE ROUGH
SCALE FOR EFFICIENCY IN PERCENT
SCALE FOR TORQUE IN POUND-FEET AND FOR EFFICIENCY IN PERCENT
SCALE FOR THRUST IN POUNDS
SCALE FOR SLIP IN PERCENT

Fig. 8

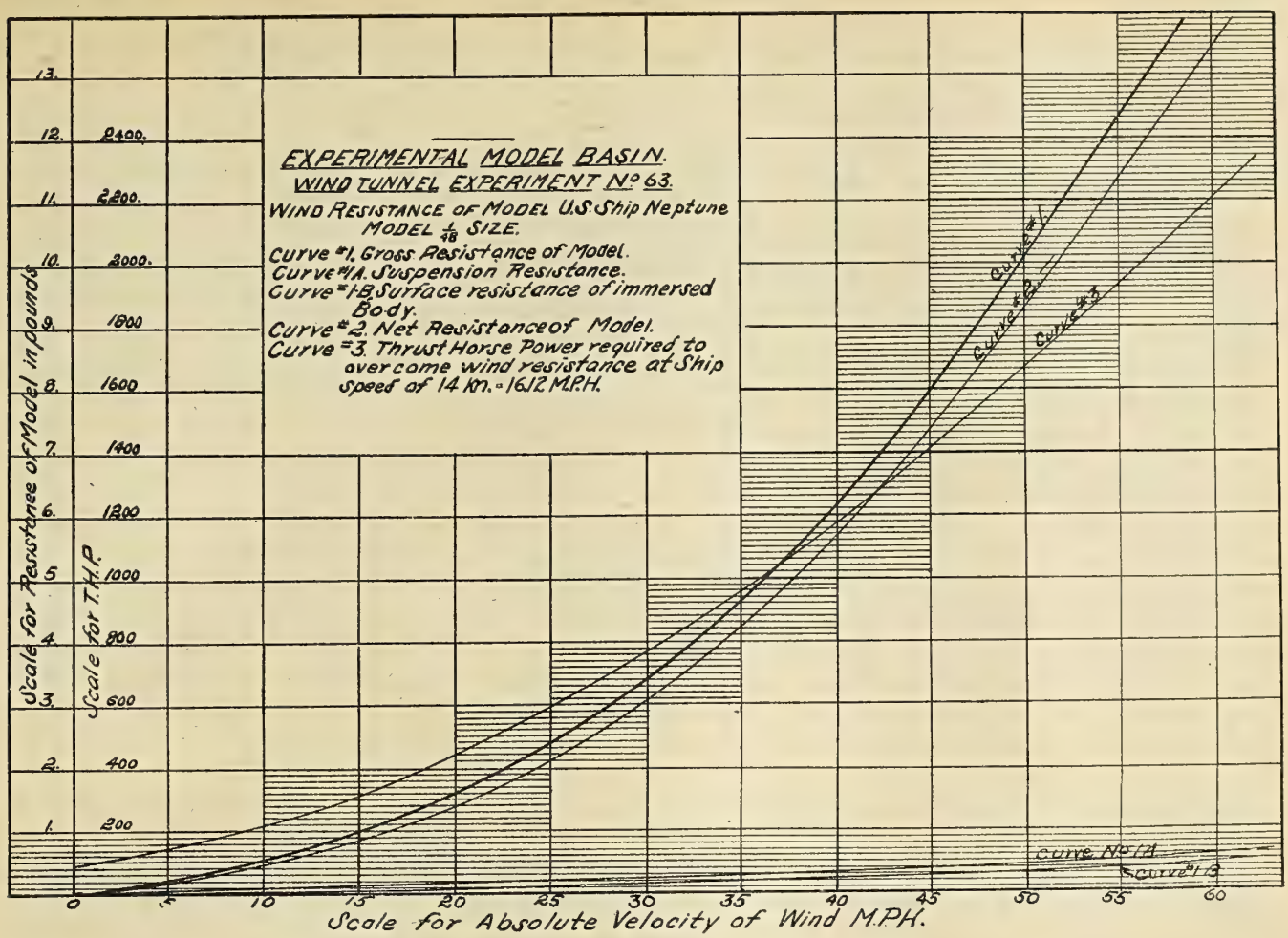


Fig. 9

As there was available an "Exhibition Model" of the ship to a scale of ¼ inch to the foot, on which all top hamper, including rigging and deck obstructions, were carefully fitted to scale, the resistance of the model was measured in the wind tunnel at the model basin.

On Fig. 10 is shown the appearance of the model as suspended in the tunnel, and on Fig. 9 the results of the test.

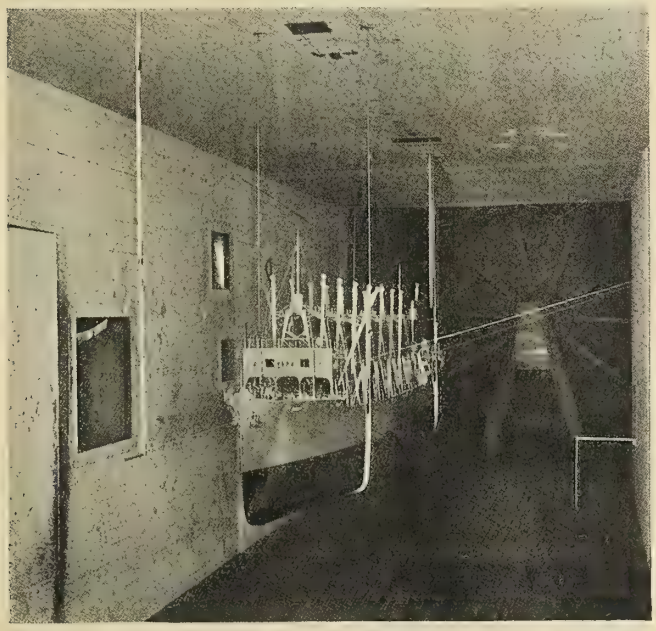


Fig. 10.—Model of Collier Suspended in Wind Tunnel

From model experiments in water it is estimated that the vessel, which is 542 feet in length over all by 65 feet beam, with a displacement of 19,340 tons at a draft of 27.5 feet, would require about 3,850 effective horsepower to attain a speed of 14 knots.

From the curves on Fig. 9 it will be seen that with a wind directly ahead with an absolute velocity of 30 miles per hour and velocity relative to the ship of about 46 miles, the additional effective horsepower to overcome wind resistance would be about 770, or 20 percent of the power to overcome the water resistance alone. This comparison leaves out of consideration any increase in water resistance due to waves. If the power developed by the engines were not increased, this additional resistance of the wind would cause a reduction in speed of about 1.9 knots.

In a general way the results of the test in the wind tunnel confirm the results obtained on trials of the vessel. No exact comparison, however, is possible, because of lack of accurate observation of the velocity of the wind at the time of the trials.

Moore & Scott Shipyard

On January 1, 1916, Mayor Rolf, of San Francisco, placed a contract with the Moore & Scott Iron Works, San Francisco, for the construction of a steel steamship, 376 feet long between perpendiculars, 52 feet 3 inches beam, molded, and 28 feet depth, molded, with a deadweight carrying capacity of 7,100 tons on a 23-foot draft. This is the first large steamship to be built at the Oakland shipyard of the Moore & Scott Iron Works, and to meet the requirements for this work and to fulfill other orders subsequently taken, the company has completely renovated



Fig. 1.—Moore & Scott Shipyard, Oakland, Cal., Showing Cantilever Yard Crane and Punch Shed and Furnace Building in Background

its shipyard, erecting new buildings and installing a complete equipment of new tools.

Three new shipways were installed and nine stationary tower cranes erected. These cranes consist of a framework with booms on each corner, as shown in the photographs. With the view of decreasing the cost of handling material, in addition to the new cranes, a complete system of broad-gage railroad track, as well as an industrial track system was installed. The material is unloaded from cars and taken direct to the punch shed by a traveling gantry crane which serves the entire plate yard. After leaving the punch shed the material is handled in the fabricating space by a 70-foot revolving crane.

New mill, joiner and pattern shops have been built and equipped with up-to-date tools. All of the punches are new and some large bending rolls have been installed, one set having rolls 25 feet in length inside the bearings and 28 inches diameter.

The Moore & Scott shipyard is equipped with an electrically operated 3,000-ton capacity marine ways and space is reserved for a large graving dock. The power house is equipped with large Ingersoll-Rand air compressors. In addition to the shipyard at Oakland, a large modern fully-equipped machine shop is operated in San Francisco.



Fig. 2.—Pattern and Joiner Shop

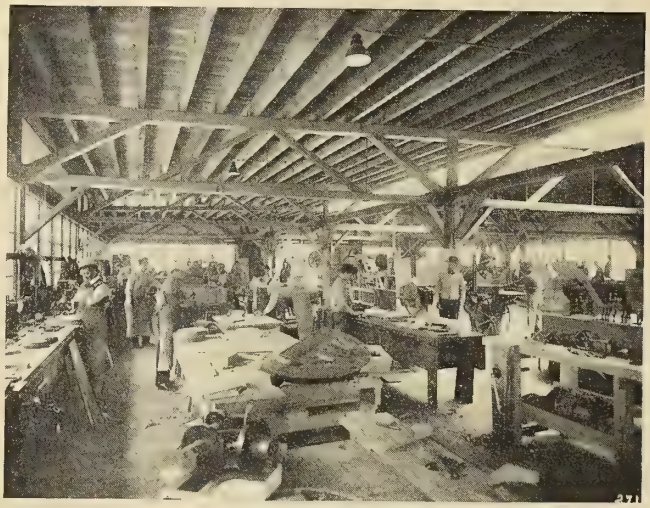


Fig. 3.—Interior of Pattern Shop



Fig. 4.—Drafting Room



Fig. 5.—Mold Loft

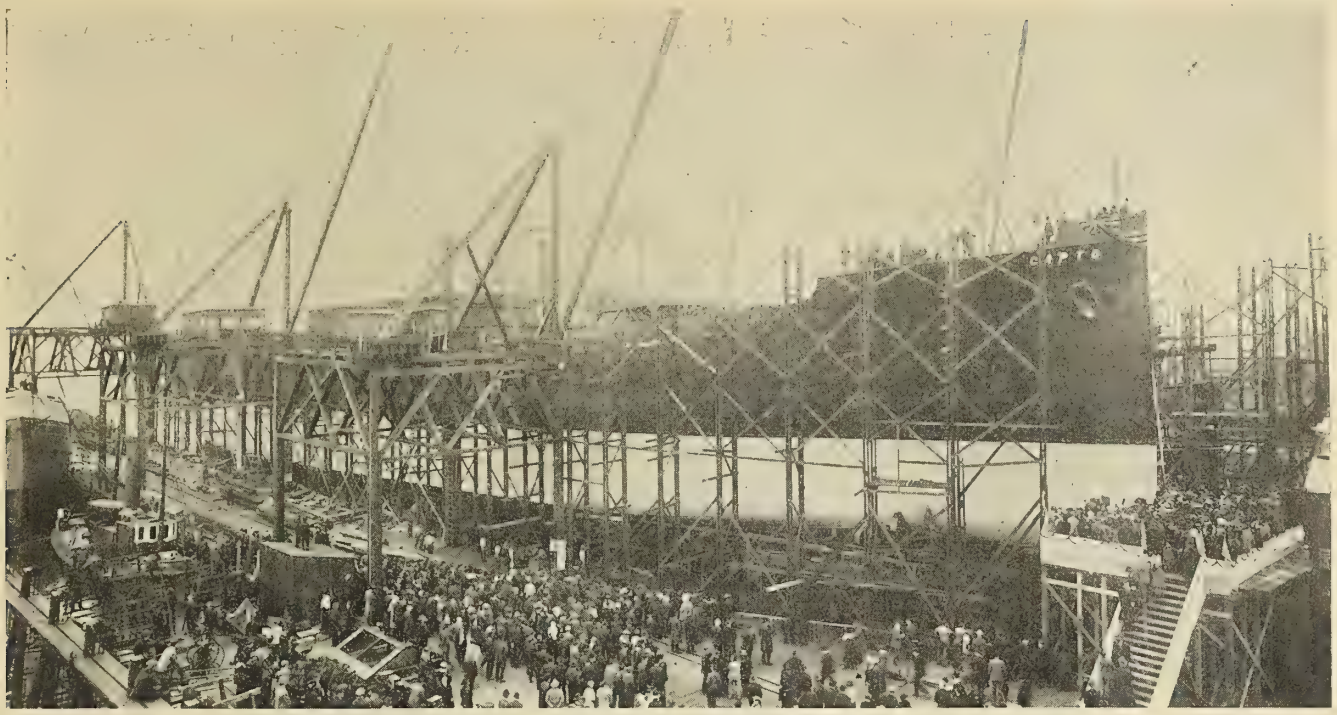
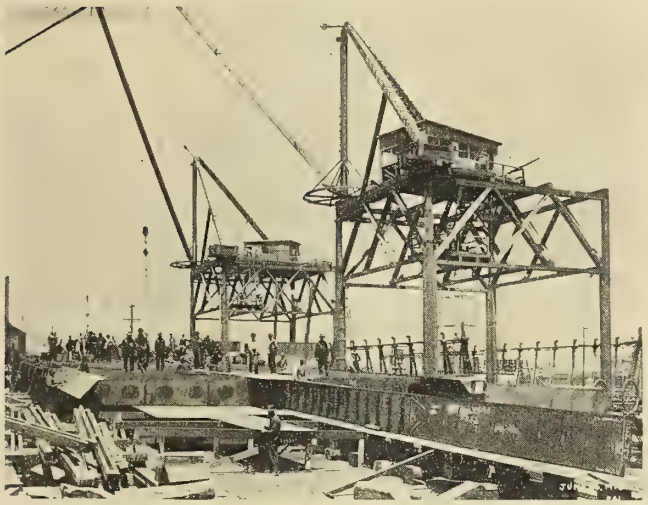
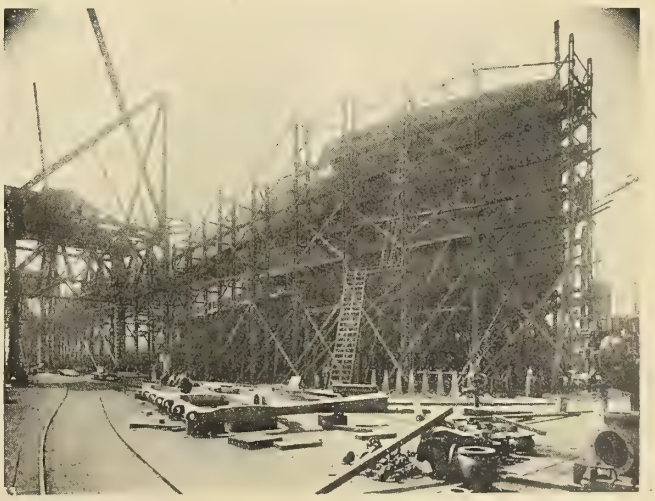


Fig. 6.—S.S. *Capto* Ready for Launching on October 14 at Moore & Scott Shipyard









Figs. 7-10.—Views Showing Progress of Construction of S.S. *Capto* at Moore & Scott Shipyard from June 26 to September 18

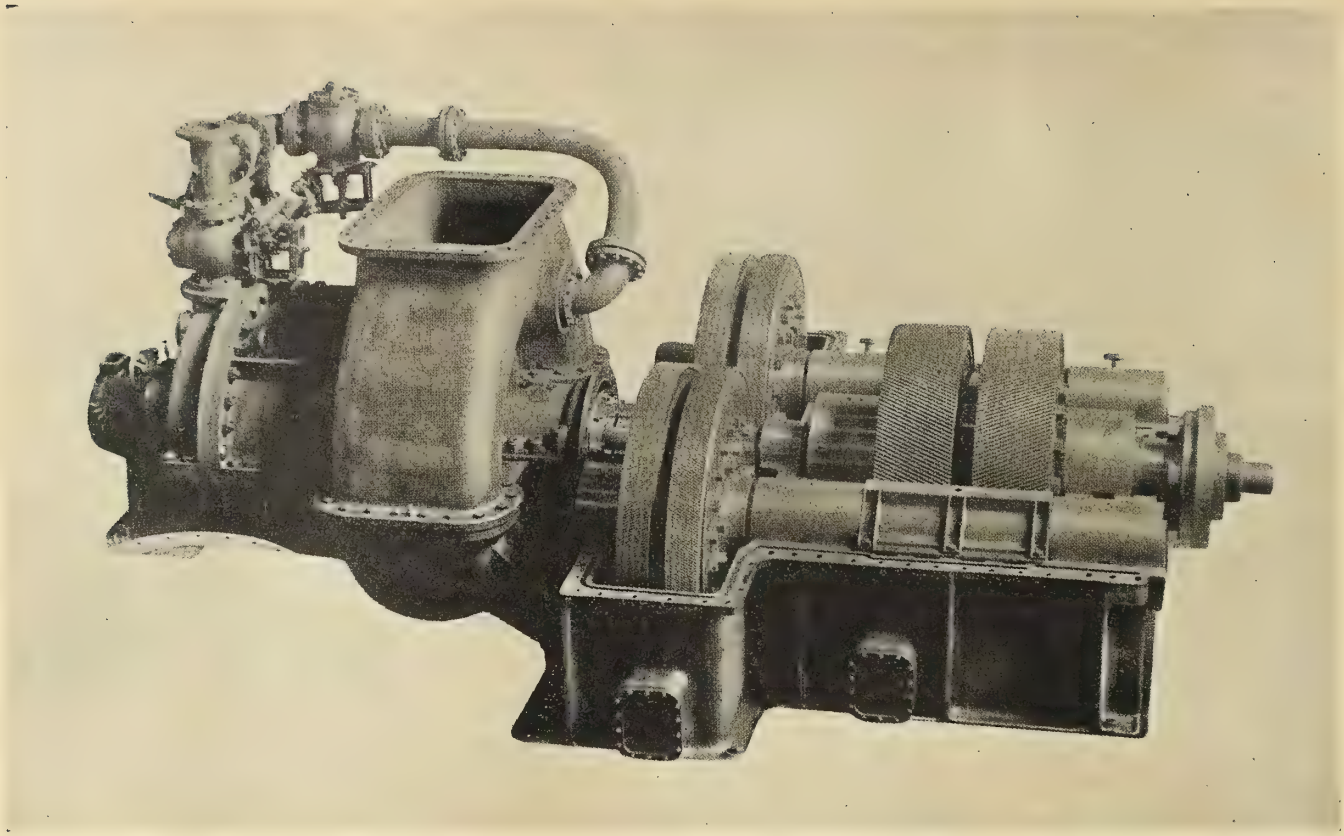


Fig. 1.—Curtis Turbine and One Plane Flexible Type Speed Reduction Gear for Ship Propulsion, Top Half of Gear Casing Removed

Alquist Gearing for Ship Propulsion*

Coustruction of Speed Reduction Gears Supplied by General Electric Company—Economics Effected in Service

BY W. L. R. EMMET

ALQUIST gearing has been applied to about seventy-two sets where steam turbines drive electric generators of various types. Contracts have been closed for machinery for the propulsion of seventy ships aggregating 215,200 horsepower. Some of these electric generating sets have been in service one and one-half years, and about seven of the ship sets are in service, some of them having made many long voyages. Among these are high pressure cruising units for the battleship *Nevada* which have been in service for some time and shown very fine results. Among the ship equipments not yet completed are included the propelling machinery for destroyer *No.* 69, built at Mare Island, and new propelling machinery for the scout cruiser *Salem.* In all of this practical experience no case of trouble with gearing has developed and no appreciable deterioration of gears has been observed.

One of the important reasons for adopting this type of gearing was that its design tended to afford a distribution of strains and means by which excessive strains would not be imposed upon any part through slight imperfections, distortions, or inaccuracies. The uniform success which has been accomplished with an entirely new product shows that this expectation has been amply justified. Some of the gears which have been used have been very imperfect, both in the matter of material and workmanship, and have been used under extremely trying conditions. That they have not failed has afforded the strongest evidence of the general reliability of the method.

The character of construction used in this gearing is shown by the drawings, Fig. 2. The gear is built up of a number of plates machined to a form which gives them the desired degree of lateral flexibility. These plates are put together, engaging solidly at the hub and also engaging on a narrow edge at the periphery. When so built together they form a solid cylinder which can be spirally cut in the ordinary manner. After cutting, the edge engagements are relieved with a small dividing tool so that each disk operates independently and is free to deflect latterly under the side pressure which results from its diagonal engagement with the pinion. The parts are so proportioned that this lateral deflection can at no time involve fiber strains which could possibly cause destructive fatigue. A very small amount of this lateral deflection is sufficient to afford the desired distribution of load, and this amount can easily be given without approaching dangerous periodic strains.

With gearing of the Alquist type we can use very small teeth without any danger of incurring excessive strains on individual teeth, which might involve risk of the development of fatigue cracks. In this connection it should be borne in mind that experiments have shown that the strongest steel, if subjected to periodic deflections, will

* From a paper presented before the Society of Naval Architects and Marine Engineers, New York, November 17

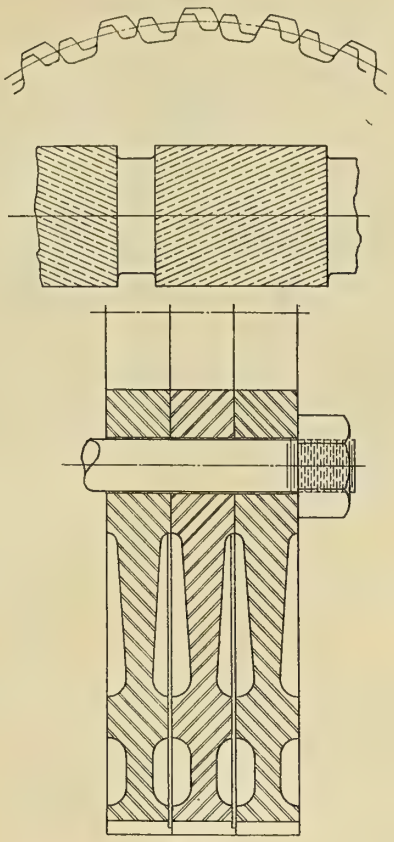


Fig. 2

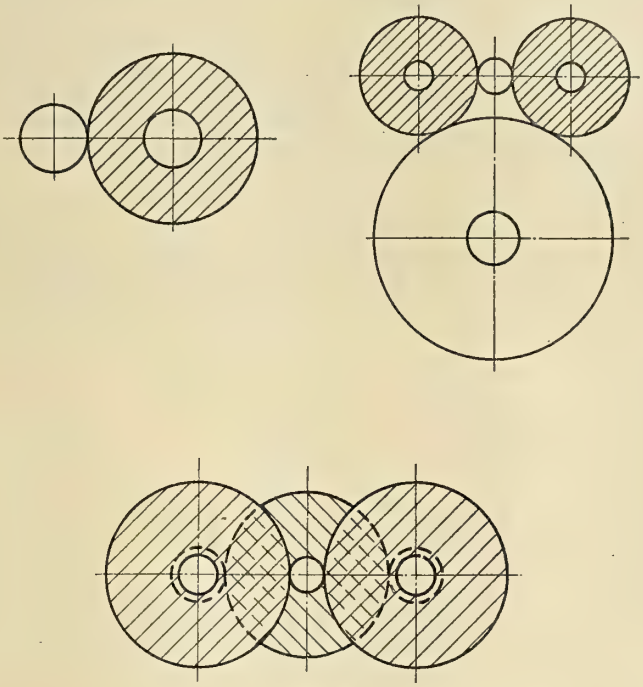


Fig. 3

break after a fiber strain of 20,000 pounds per square inch has been applied a million or more times.

In the work which is now being done by the General Electric Company, gears of the type described are applied in three ways. First, a single reduction has been accomplished by engaging one solid pinion with a flexible gear of this type; second, by engaging a solid pinion with two flexible idlers, which idlers in turn engage with a solid large gear; and third, in a double reduction where a solid, high-speed pinion engages flexible gears on two countershafts, these countershafts carrying solid pinions, both of which engage a flexible gear on the same low-speed shaft. In these two latter applications the flexibility of the gears serves to equalize the loads between all of the driving points, and the use of a plurality of driving points on the large gear reduces the length of face necessary on that

TABLE I.

S. S. "La Brea."

Voyage.	Date.	Total Distance in Knots.	Average Speed in Knots.	Total Barrels Delivered.	Name of Port.	Total Fuel Used Steaming on Voyage in Barrels.	Total Barrels Per Knot Steaming.	Total Barrels Used in Port.	Total Barrels Per Knot Steaming and in Port.	Time in Port Hours.	Barrels Discharged Per Hour.	Cost at 80 cents per Bl. Per Knot Steaming and in Port (Fuel.)	Shaft Horsepower Hours.	Pounds of Oil Per Shaft Horsepower
	1916													
1	March 9 to 15... ...	650	9.5	62,578	Oleum.....	574	.883	142	1.10	36½	1,714	$.88	116,000	1.67
2	March 15 to 26.....	2,037	11.33	73,600	Seattle.....	1,459	.716	152	.79	37½	1,962	.632	505,000	.941
3	March 28 to April 6..	2,108	11.01	64,676	Vancouver.....	1,584				26	2,487			
				8,642	Seattle.....	1,584	.751	155	.824	13½	640	.659	530,000	1.01
4	April 8 and May 16..	9254.5	10.97	52,109	Taltal Antofagasta	6,896				33¾	1,544			
				19,045		6,896	.745	117	.757	15½	1,228	.605	2,330,000	1.00
5	May 17 to May 23...	450	11.20	77,292	Oleum.....	321	.713	134	1.01	39	1,980	.808	118,000	.911
6	May 24 to July 1....	9196.5	10.65	71,824	Antofagasta.....	6,900	.75	109	.762	25	2,660	.609	2,200,000	1.06
7	July 1 to Aug. 9.....	9,184	10.39	71,791	Port San Luis to Antofagasta, Chile, and return.....	6,875	.748	107	.76	42.3	1,697	.609	2,230,000	1.04

Average speed 10.9. Total pounds of oil steaming = 8,270,000. Total shaft horsepower hr. 8,029,000. Pounds of oil per shaft hosrepower hour = 1.03.

S. S. "LOS ANGELES"

1	April 9 to 15.....	423	9.4	67,674	Oleum.....	556	1.31	164	1.70	64½	1,099	$1.36	74,600	2.48
2	April 16 to April 25..	1,345	10.13	74,739	Vamcouver.....	1,656	.897	218	1.01	33¾	2,214	.808	394,000	1.41
3	April 27 to May 25..	6,549	10.22	73,734	Panama.....	5,579	.851	169	.877	46¾	1,577	.701	1,420,000	1.315
4	May 26 to May 29...	220	9.1	72,372	Oleum.....	221	1.00	123	1.56	41	1,770	1.24	39,000	1.88
5	May 30 and June 27.	6,348	10.6	72,538	Bal-Boa.....	5,462	.86	159	.885	35	2,072	.708	1,460,000	1.255
6	June 29 Aug. 7, 16...	9,151	10.24	71,007	Port San Luis to Antofagasta, Chile, and return.....	8,293	.906	186	.926	56.3	1,261	.74	2,130,000	1.31

Average speed 10.27. Total pounds of oil steaming = 7,310,000 Total shaft horsepower hours, 5,538.000. Pounds oil per shaft horsepower hour = 1.320



Shipyard of the Peninsula Shipbuilding Company at Portland, Ore.

gear. These different methods of application are illustrated by diagrams in Fig. 3.

In both of these cases where a single high-speed pinion drives two flexible gears, other very positive advantages are accomplished. The pinion is relieved of bending strains, and pressure on the high-speed bearings is avoided.

Experiments have been made in Schenectady which carefully analyze the losses of high-speed gears under various conditions of load and pressure, and these experiments have indicated that low peripheral speeds are more efficient than high speeds. With solid gears low speeds involve difficulties because they diminish pinion diameters and increase pinion lengths, thus complicating the troubles which may arise through deflection and torsion of pinions and pressure upon pinion bearings. Since the flexibility of Alquist gears enables us to compensate easily for all possible degrees of torsional yield in the pinion, we can with such gears safely reduce peripheral speeds by making the gears longer and of smaller diameter. Such reductions of diameter diminish weight and improve efficiency, and the fact that the Alquist method makes such reductions possible constitutes one of its important advantages.

Table I shows a comparison of performances for two sister ships, the *La Brea* and the *Los Angeles*, operated by the Union Oil Company, of Los Angeles. Both of these ships are new, carry similar cargoes and burn the same fuel oil in the same boilers under similar conditions. The *La Brea* is fitted with our geared-turbine equipment, and the *Los Angles* is fitted with triple-expansion engines of the best type. The *Los Angles* is equipped with steam-driven, oil-handling pumps of the ordinary type, and the *La Brea* is fitted with a new arrangement of pumps driven from the upper deck by General Electric motors. The table illustrates the superiority of the oil-handling machinery as well as that which propels the ships. The horsepower-hours given in this table are calculated from the propeller and hull data given by the naval architect of the Union Iron Works, who built the ships, and based upon model tank experiments which were made in Washington. The models of the ships are identical, the *La Brea* propeller operating at 90 revolutions per minute, and that of the *Los Angeles* at 65 revolutions per minute.

The seventh voyage of the *La Brea* and the sixth voyage of the *Los Angeles* were made over the same course and at nearly the same time. The relation of fuel economy of these two voyages almost exactly corresponds to that shown by the average of all the voyages and tends to verify the accuracy of the whole comparison.

Peninsula Shipbuilding Company to Build Wooden Vessels at Portland, Ore.

With the recent revival of wooden shipbuilding in the United States, a number of new shipyards have been established in the Pacific Northwest on account of the abundance of shipbuilding timber available in that part of the country. The district in which this revived industry has largely centered is along the Columbia River in the vicinity of Portland, Ore. As Portland has more large sawmills than any other city in the world, and the state of Oregon contains one-fifth of all the standing timber in the United States, the building of wooden vessels in this district can be accomplished with a minimum of cost for the transportation of raw materials.

One of the latest companies to establish a shipbuilding plant in Oregon is the Peninsula Shipbuilding Company, which has a tract of land with a frontage of 3,100 feet on the Willamette River, and an average depth of 1,900 feet. The plant is equipped with a full cutting up mill, including band saws capable of tilting 45 degrees either way from a vertical line, air compressors for riveting, etc. A complete machine shop has been erected in which the machine tools are driven by electricity. Electric cranes are used for the delivery of material to different parts of the shops, and the plant draws a supply of Douglas fir timber from its own mills located within about 200 feet of the shipways.

F. C. Knapp, president of the Peninsula Lumber Company, is president of the new company, and the board of directors includes the following, all of Portland: A. L. Mills, president First National Bank; W. M. Ladd, president, Ladd & Tilton Bank; J. C. Ainsworth, president, U. S. National Bank; Peter Autzen, president, Peninsula National Bank; T. B. Wilcox, president, Portland Flouring Mills; J. C. Kerr, of Carey & Kerr, attorneys, and Mr. Knapp, president of the company.

MECHANICAL ENGINEERS' ANNUAL MEETING.—The annual meeting of the American Society of Mechanical Engineers will be held at the Engineering Societies Building, 29 West 39th street, New York city, December 5 to 8. The technical papers will be discussed in groups divided among the following subjects: Industrial Safety, Textile, Machine Shop, Valuation, Gas Power, Railroad, Steam Boiler and Miscellaneous. The annual address of Dr. D. S. Jacobus, president of the Society, will discuss the Relation of Education to Engineering.

Naval Architects' Annual Meeting

Twenty-Fourth General Meeting of the Society of Naval Architects and Marine Engineers—Abstracts of Papers Read

THE twenty-fourth general metting of the Society of Naval Architects and Marine Engineers was opened on Thursday morning, November 16, in the main auditorium of the Engineering Societies Building, New York City, with Mr. Stevenson Taylor, president of the society, in the chair.

The first business was the reading of the annual report of the secretary and treasurer, which showed that 808 members were enrolled in the society on November 1, 1916, as against 793 a year ago. According to the treasurer's balance sheet, the society's present worth on October 31, 1916, amounted to $30,788.48 (£6,300).

The following deaths were recorded during the year: David Almy, James M. Lincoln and William A. Perry (members), and Ralph D. Williams (associate).

In accordance with action taken by the Council, President Taylor brought before the society a suggestion submitted by Mr. T. M. Cornbrooks during the summer to the effect that a permanent committee be appointed to represent the society at public hearings regarding matters that come within its scope, or on other occasions where the advice, experience and scientific knowledge of the society as a body would be of value to the public. The society voted to authorize the executive committee to appoint such a committee.

The names of 77 applicants for membership in the society were read by the secretary and their election was duly ratified by a unanimous vote of the society.

The following officers were elected for the terms specified:

Vice-presidents for term expiring December 31, 1919.—R. M. Watt, A. P. Niblack, W. M. McFarland, J. W. Miller.

Members of Council for term expiring December 31, 1919.—C. P. Wetherbee, J. H. Linnard, C. A. McAllister, W. L. R. Emmet, J. H. Gardner, H. C. Higgins.

Associate members of Council for term expiring December 31, 1919.—R. A. C. Smith, Albert W. Goodrich.

Executive committee for year 1917.—W. L. Capps, F. L. DuBosque, W. I. Babcock, Andrew Fletcher, W. M. McFarland.

Committee on papers for year 1917.—W. M. McFarland, F. L. DuBosque, W. I. Babcock.

Secretary-treasurer for year 1917.—Daniel H. Cox.

The president then delivered his annual address, extracts from which will be found on page 523 of this issue.

The following papers were then read and discussed:

New Method of Indicating the Density of Smoke as Installed on the U. S. S. Conyngham

BY REAR ADMIRAL R. T. HALL, U. S. N.

ABSTRACT

This system, installed on the after stack of the U. S. S. *Conyngham*, consists of a light transmitter installed on one side of stack, a light receiver installed on opposite side of stack to light transmitter, and an indicating meter with suitable control appliances installed in boiler room. The indicating meter is provided with a scale of smoke densities, ranging from dark to clear.

This system was in successful operation during the official trial of the vessel and was found to operate satisfactorily under all conditions of smoke.

Scale indications at various densities of smoke were checked up by a member of the trial board with observations made visibly from deck, and were found to be correct.

The basic principle of operation of the system is dependent on the peculiar property of the metal selenium, which, under certain conditions of crystalline structure, is light sensitive in its resistance to a passage of electric current, viz., of low resistance at higher light intensities, and vice versa of high resistance to lower light intensities.

It will be manifest, if a beam of light be projected across a stack, that its intensity will vary with the density of the smoke. It will be further manifest, if a plate of selenium of suitable structure is placed opposite to the source of projected light, its electrical resistance will also vary with the density of smoke, and, by connecting the selenium plate in series with a suitable indicating meter and a source of electric current supply, such variations of smoke density will be made manifest by variation in current flowing through meter and, by suitably arranging the meter scale, such variations in electric current will be indicated as smoke densities.

On a metal plate installed in the boiler room, in a location readily observable by attendants, is installed the smoke indicating meter and a potentiometer, which is provided with a slidable brush for adjusting the potential on the selenium plate, and serves as a simple and effective means for setting the indicator on the clear indication, as when no smoke is issuing from stack.

The system is connected to the ship's lighting battle main at 125 volts.

The following general advantages are claimed for the system:

(*a*) Making it possible for attendants in boiler rooms to observe directly the character of smoke issuing from stack and enabling them to adjust the amount of fuel and air necessary for perfect combustion.

(*b*) Prevention of soot deposition on heating surfaces, such soot impairing the evaporative efficiency.

(*c*) Informs firemen of smoking condition of stacks and serves as a means for elimination of the many objections to same.

(*d*) Elimination of personal error from a naval strategical standpoint in determining smoke densities. At present the recording of smoke densities is dependent on the human vision in comparison to arbitrary shades and colors.

Salvage Equipment Used in Raising Submarine F-4

BY NAVAL CONSTRUCTOR J. A. FURER, U. S. N.

ABSTRACT

The United States submarine *F*-4 failed to return from a submerged run made outside of Honolulu harbor on March 25, 1915. The vessel was definitely located on the following day in 304 feet of water. After making a number of fruitless attempts to drag the submarine into shallower water by means of sweeps, it became apparent that direct lifting was the only practicable salvage method.

The problem consisted of lifting 260 tons, the submerged weight of the submarine. Briefly, the salvage method consisted of sweeping four wire hawsers under the vessel—two forward and two aft. The ends of these hawsers were brought up through the central mud-pocket

openings of two bottom dumping mud scows, each 104 feet long by 36 feet beam by 13 feet deep, and were then attached to specially constructed windlasses mounted over the pockets. Two windlasses were installed on each scow, one for each hawser. By winding up the hawsers on these windlasses the vessel was thus lifted in the loops of the four slings. Power was supplied on each scow by a two-drum, 8-inch by 10-inch hoisting engine.

In order to provide a margin of reserve power for starting the vessel provision was made for using the buoyancy of the scows. A flood valve was fitted in the bottom of each scow and pumps were installed on deck for unwatering. Stability calculations indicated that the scows would be unstable with the load suspended from the windlass shafts because of the internal free water surface. In order to counteract the upsetting moment due to the negative metacentric height under these conditions, should it become necessary to flood the scows, heavy timber cribbing was fitted around the bottom of the mud-pockets for restricting the swing of the lifting hawsers. This timber cribbing also served the purpose of protecting the structure of the scow itself from the cables.

Six cables as follows, each from 900 to 1,000 feet long, were used for lifting at one time and another—one 2⅝-inch plow steel, one 2-inch plow steel, two 2½-inch galvanized crucible steel, and two 2¼-inch galvanized crucible steel hawsers. The two plow steel hawsers, especially the 2⅝-inch hawser, proved the most satisfactory, because they resisted chafing to a much greater degree than galvanized wire. On the other hand, the plow steel cables were much harder to handle and to sweep because of their stiffness.

A dredge equipped with an adequate power plant, including a dynamo, was used as a base for conducting the salvage operations. As the dredge could not be moored in the customary manner on account of the great depth of water to seaward, the expedient adopted was to use the submarine itself as the seaward anchor. This was accomplished by sweeping a wire hawser around both the bow and the stern of the vessel.

Plain wire hawsers of the sizes mentioned were first used for lifting the submarine. These hawsers were swept under the vessel by tugs. Divers were sent down after each line was swept into place to report on its position.

The diving on this job established a new record. On this job the men were not kept on the bottom intentionally more than from ten to fifteen minutes at a time. It was fortunately not found necessary to call on the divers to do manual work while the vessel was in deep water. Their function consisted of observing the location of the lines and reporting on the steps necessary to bring them into the positions desired.

After lifting the submarine about 12 feet and towing inshore a corresponding amount, one of the galvanized hawsers parted. On being brought to the surface it was quite evident that the stranding had occurred at the bilge keels. Its replacement was somewhat delayed by the weather, but this was finally accomplished and another lift was made. A hawser again parted and could not be immediately replaced on account of bad weather. While the scows were riding out the weather, one cable after another parted, the last to go being the 2⅝-inch plow steel cable. Altogether a lift of 25 feet was accomplished with the wire hawsers.

In view of the rapid impairment of the cables by chafing, a 15-fathom shot of chain was next inserted in the middle of each sling where it passed under the submarine. After working twenty-one days all four slings were again in place and lifting operations were resumed. Good progress was made in hoisting and towing to shallower water. A depth of 50 feet was reached close to the harbor entrance, when a heavy ground swell and bad weather set in very suddenly and wrecked the whole operation.

On taking into consideration various phases of the situation it was decided, on account of heavy weather, to change the plan of operations. The strongest reason, however, for changing the salvage plan was that the submarine might break in half while being taken through the channel, if lifted by the scows. This would have blocked the harbor to navigation, as there was no water shallower than about 40 feet in which the vessel could be landed, it was necessary to resort to a salvage method which would provide for lifting the vessel from a depth of 50 feet to a depth of not more than 25 feet at one step.

The use of submersible pontoons offered the best solution of the problem. The plan adopted called for the use of three pontoons on each side of the vessel connected in pairs by chains passing under the boat and up through hawse pipes in the pontoons. Four of the pontoons—the bow and stern pairs—were made 32 feet long by 11 feet in diameter. The other two were made the same length, but were 12 feet 6 inches in diameter. The buoyancy—that is, the lifting capacity—of the 11-foot cylinders was 63 tons, and, of the larger cylinders, 84 tons. The combined lifting capacity of the four pontoons was 420 tons. This provided excess capacity of 160 tons over the estimated weight of the submarine.

Securing the pontoons to the submarine was one of the most important features of the salvage arrangement. Chains were rove under the vessel and, while the pontoons were afloat, were brought up through the hawse pipes already mentioned. After the pontoons had been landed on the bottom, cast steel clamps were bolted around the chains just above the hawse pipes.

Compressed air taken from torpedo air flasks was used for unwatering the pontoons.

The work of passing the chains under the vessel took three working days, with a few intervening days when the swell and undertow were so heavy that divers could not stay on the bottom. The job of substituting the coal lighter, with its equipment of air flasks, for the wrecking barge was completed on Saturday, August 28, too late to unwater the pontoons on that date. The final work of connecting up the hose leads to the pontoons and opening the discharge and blow valves was started at daybreak on Sunday, August 29.

When all necessary preparations had been made a diver was sent down to watch the pontoons and to report by telephone as they became buoyant. The air was first started on all four compartments of the stern pontoons. When this pair was buoyant the air was shut off and the middle pontoons were started off the bottom in the same manner. In the case of the bow pontoons it was necessary to bring the forward end of the seaward cylinder off the bottom in advance of the after end in order to clear the bow rudder on this side, which was still in place and projected upward at an angle of about 45 degrees. If this precaution had not been taken the pontoon would have jambed against the sharp point of the rudder and would probably have sprung a leak. The pontoons were all partly unwatered before turning on the air to all six cylinders, in order to make certain that all the lines and discharge valves were functioning properly.

When the pontoons had in turn been brought to a reasonably horizontal position by manipulating the manifold valves, air was turned on to all twelve compartments. One end of the submarine came up slightly ahead of the other, as was inevitable.

Once the pontoons emerged they immediately adjusted

themselves automatically, as the high ends ceased to be water borne, and therefore exerted no pull on the chain. This permitted the buoyancy of the low end of the opposite pontoon to assert itself, thus causing the chain to render.

Discussion

Captain A. P. Niblack, U. S. N., pointed out that while other nations have provided special salvage vessels for work of this kind, the United States has not followed this custom because of the extent of our coast line and the distance apart of our naval bases. Hitherto the handling of our submarines has been rather disconnected, but the naval board is now considering the establishment of additional submarine bases, and it is possible that this might lead to the provision of special submarine salvage vessels. Captain Niblack also pointed out that the splendid work of the divers in salving the *F*-4 demonstrated the efficiency and usefulness of the diving school conducted by the navy for many years and now located at Newport, R. I.

Naval Constructor Furer stated that the salvage of the *F*-4 was the best demonstration that a special type of submarine salvage vessel is not a good investment. In this case the salvage operations cost about $125,000 (£25,600), which represents only a small proportion of the cost of a salvage vessel, and to meet the requirements of the United States navy, at least four such vessels would be necessary. The important problem in raising the *F*-4 was in getting shackles under the boat and not the application of power in raising the vessel. The question of speed in salvage operations would be of importance only in case of saving lives.

The Design of an Oil Engine

by John F. Wentworth

Abstract

The type of engine selected was a four-cycle oil engine designed for naval use to fill the following conditions: Brake horsepower, 450; revolutions per minute, 450; length overall, not to exceed 14 feet 9 inches; width, not to exceed 3 feet 8 inches; height above center of shaft, not to exceed 6 feet; distance below center of shaft, not to exceed 23 inches; weight, not to exceed 26,000 pounds. To meet the conditions a six-cylinder engine was designed with cylinders of 13 inches bore by 12-inch stroke. The compression at full load was fixed at 200 pounds per square inch. In this respect the engine presents a radical departure from the Diesel type of heavy oil engine, in which the pressure of compression is usually about 500 pounds per square inch.

The engine is divided into two sections of three cylinders each with the couplings, reverse gear and fuel pump placed between the two sets of cylinders. While the fuel and admission valves must be subject to regulation as to timing, etc., and the starting and exhaust valves do not need this regulation, the fuel and exhaust valves are placed on the front side of the engine and the starting and admission valves on the back side.

For starting the engine it is proposed to use steam instead of compressed air, steam being admitted to the water jackets of the cylinders to reduce condensation of the steam in the cylinders. As soon as the engine is firing on oil the jackets are to be filled with water and the engine will then follow the conventional Diesel type in its cycle. For supplying steam for this purpose the author proposes a special type of boiler fired by oil fuel when the oil engine is not in operation and heated by the exhaust from the engine when the engine is in operation.

The paper gives a detailed description of the cam gear for operating the valves as well as of the mechanism for reversing the engine. The fuel is fed to the engine by a fuel pump of novel design. Instead of a slow-moving pump plunger, the fuel pump is fitted with a floating piston, which is lifted in the delivery stroke by a lever operated by a cam. The plunger is returned by springs at the bottom of the plunger and is at all times kept against the lever by means of the spring. The motion of the lever determines the stroke of the plunger and the movement of the lever is controlled by an eccentric shaft. With full eccentricity of the shaft up the lever is held so that the cams clear and no fuel is delivered. With the shaft turned an angle of 180 degrees, the maximum stroke of the plunger is obtained. Any desired position may be obtained for the shaft between these two extreme positions, and so the amount of fuel delivered may thus be governed. The feature of this pump is not only to deliver exactly the fuel required, but to deliver this particular amount and at just the moment it is needed. By varying the position and this setting of cams, the action of the fuel pump may have a different timing.

The fuel valve is also of novel design, being a double valve. The air for injection has one seat and the fuel goes through another seat. The lift of the fuel plunger should be timed to act with the opening of these two valves, so that the fuel will be delivered by the pump directly into a stream of moving injection air. In this valve the fuel starts after the air has started and stops while the air valve is still open. The result is that the fuel valve should give no trouble with clogging, as it is cleared by air after each delivery stroke. A fuel heating tank is supplied in which the fuel is heated by means of a coil of steam pipes within a tank.

Aeronautics in Relation to Naval Architecture

by Naval Constructor H. C. Richardson, U. S. N.

Abstract

Early in 1911 work was started at the model basin at the Washington Navy Yard, with a view to the development of floats for aeroplanes. This work has been constantly followed up by making tests of model floats of all descriptions, and particularly with models of floats actually furnished, or proposed, for use with naval aeroplanes. In addition to this, series of models embodying variations of particular features were tried from time to time, covering a wide range of possible useful features, and, where such models showed sufficient merit, full-size construction has been carried on, and the full-size floats have been given tests in actual service. A detailed account of the complete series of tests would be too voluminous for reproduction, and would cover many defective types, so the paper enters only into a general discussion of types and the requirements for floats for naval aeroplanes.

The principal differences existing between the conditions of use of aeroplane floats, and those met in the use of ordinary displacement vessels, or vessels of the hydroplane type arise from the fact that as the square of the speed increases the lifting power of the wings becomes more and more important, and the load carried by the aeroplane float constantly diminishes until at the get-away speed no load is any longer carried by the float. At the higher speeds near the get-away conditions, the form of the bottom of the float becomes unusually important, due to a prominent suction effect which is present if any downwardly bowed lines of flow are presented.

Many forms and dispositions of floats have been proposed and tried, and for inland waters several successful

forms now exist, but for work in the open sea no form is yet known to have all the required qualities.

The first success was attained by Curtis with floats of an exaggerated blade form, but these were not as satisfactory as the normal rectangular section float having a skidform profile. This is a simple and successful form for inland work, and it seems to matter little from a resistance point of view what form of bow curve is used. Close agreement was found in performance of bows having widely different forms of curvature. Various other forms of bows were tried—convex, concave, flat sloping bows, corrugated bows—and all show essentially the same characteristics.

The influence of steps has been tried—one, two, and up to six. From a resistance point of view it appears unnecessary to provide more than two steps for aeroplane conditions. The first break is usually placed nearly under the center of gravity, and the second forms the stern of the float. If both steps are inclined in the same sense a biplane float is formed, but if the after step rises relative to the forward one, it more nearly approaches the monoplane or single-step form, which has desirable qualities. This is the form which has proved so successful in the flying boat. Ventilation of the steps facilitates quick planing and is useful, but is not essential if there is ample reserve of power.

Interference between twin floats at the separation usual in practice appears inappreciable, except at very low speeds.

Flat-bottom floats pound heavily and the flat-bottom-step type porpoises strongly unless it is handled very nicely, even in smooth water.

The introduction of a moderate V-bottom greatly reduces the shock of landing on smooth or rough water. All straight V's throw a strong sheet of spray at the bow. This sheet of spray appears to be independent of the true bow wave. It can be suppressed by the use of hollow V-lines at the bow, but this form is difficult to build strongly and has bad steering tendencies when trimmed by the bow or when making a skidding landing or get-away. A simpler method of suppressing this bow spray is the use of mud guards, so-called for obvious reasons.

The V-bottom also greatly reduces the danger of sticking a wing under on a skidding landing, or when running at high speed across the wind.

The use of fine lines at the bow or stern is not very general, because of the need of longitudinal stiffness. Such lines steer badly, and there is some evidence of the suction effect being present. It is not improbable, however, that a compromise between such lines and the V-bow may work out in solving the seagoing problem.

In construction details in this country the boat-builders' influence is just being asserted. The principal builders have followed a box-like construction not disposing of their material to advantage. In recent efforts to develop a stream-line form of float, the general form is as nearly stream line as practicable, having a curved deck comprised of two-ply spruce, applied diagonally, one across the other, with cotton sheeting and marine glue between the plies. This construction eliminates the usual deck joints and provides the arched form with diagonal bracing, continuous from chime to chime.

Through the center of the float a longitudinal truss provides the backbone of the construction. Two-ply bulkheads support the float attachments, and the principal bulkheads are tied to each other and to the step by a two-ply fore-and-aft bulkhead built into the center-line girder. These bulkheads are bound by oak ribs and intermediate ribs of oak support the top shell.

The bilge stringers and the keelson are continuous, the step being formed by tapered liners. The step is of oak, as when grounding, or when planing at high speed, the loads are concentrated at the step. The bottom is two-ply spruce, the inner ply running athwartships and the outer ply running diagonally outboard and aft from the keel to the bilge stringers.

Cotton sheeting and marine glue are used in all two-ply work and the plys are held together by special clinch nails of brass.

The bottom is supported by the keel and bilge stringers and an intermediate longitudinal, which are in turn supported by the step and bulkheads. The stem and stern pieces are of spruce, shaped to take the longitudinal members and rabbeted to receive the shell planking. The system of bottom planking and longitudinals eliminates the use of bottom frames and really provides continuous framing in the planking itself, similar to Hands' original V-bottom construction. This type of bottom planking appears resilient and strong.

In assembly all butts are covered with glue. All woodwork is given two coats of shellac as soon as it is in place, and is finally given two coats of varnish to prevent the absorption of moisture.

All boundaries of the bottom are sheathed with brass strips set in marine glue. This affords protection and insures watertightness. The float attachments are locally reinforced and strengthened to transmit the loads to the important members.

Each of these floats, designed for 1,000 pounds displacement and 60 percent reserve buoyancy, weighs, complete, 125 pounds. The principal dimensions are: Length, 15 feet; maximum beam, 24 inches; maximum draft, 14 inches.

The floats have been used in service with very satisfactory results. The aerodynamic properties of these floats are good. They have the least resistance when the deck is inclined at —3 degrees to the wind, and in this position have no lift; consequently, they present a minimum disturbance in the equilibrium of the aeroplane.

Discussion

Mr. Elmer A. Sperry emphasized the difficulties which this problem presents, citing the case of the hydro-aeroplane *America*, which, while a successful flyer, was hard to get out of the water. It was found that a flaring bow helped in breaking the bow waves, allowing the boat to rise. While rectangular floats separate easily from the water they are not suited for use in rough water. It is of the utmost importance to secure a seaworthy boat that will separate itself from the water.

The Power-Forging of Chain Cables

BY NAVAL CONSTRUCTOR FREDERIC G. COBURN, U. S. N.

Abstract

There has been developed during the last two years at the United States Navy Yard, Boston, Mass., a power-forging process for the manufacture of chain cables which has been highly successful. No great mechanical difficulty was experienced in the manufacture of chain by hand until diameters as great as 2¾ inches were reached; even that size was fairly well handled; but when the 3-inch cables were taken up serious difficulties were encountered on account of the size of the metal, the mechanical difficulties involved and the very hard labor required of the chain makers' helpers. It was not only difficult to get chain makers to make a good chain; it was ex-

ceedingly difficult to get them to attain a satisfactorily high rate of production and regularity of attendance.

The causes of the inferiority of hand-made welds become apparent after experience in the testing pit. The helpers cannot hit hard enough with their sledges to drive the two scarfs together. The welding surfaces are not smooth, because they are formed by peening; pockets are thus formed, which retain slag; and the hammering does not work out this slag. Thus the weld is incomplete. Sometimes a pocket as big as a half-dollar is found, occasionally open to the sea by a small crevice. Fractures have been produced in proofing old chain which showed that not over 10 percent of the surfaces was welded; only the strength due to form, assisted by the tacking together of the scarfs, had held those links intact in service.

In the large chain it was impossible to finish the inside of the link at the welded end, thus leaving a hollow and reducing the sectional area.

Another serious defect in the hand-welded chain is the wasting of the material, in the fire, just back of the weld. There is no way to make this up except to increase (uniformly) the diameter of the metal in order to have the full diameter in this quarter. In the power-forged link, however, the metal is upset slightly before scarfing, completely avoiding this deficiency.

To sum up, the hand-made welds are not complete, not uniform and not reliable. The need of a power-forging process was therefore apparent.

The first attempt was made with a Bradley helve hammer, because that hammer hits a rapid, elastic blow, which appeared to simulate the blows of the hand sledge. That method was found impracticable, and resort was then had to ordinary steam hammers. All the experiments had been made on the 3-inch size, and at the time referred to there were available the dies that had been made for the purpose. Briefly, the process consisted of shearing the bolt to length as usual for the hand-welders, in a large power shears; bending up the end of the bolt in a 6-inch Ajax upsetting machine; putting on the scarf in a 2,500-pound steam drop hammer; bending the link by hand around a mandrel; welding the link under a 350-pound, single-frame steam-forging hammer; and then, in another heat, finishing the link under dies fitted to a 3,000-pound, double-frame forging hammer; trimming off the "flash" by hand.

While this process made chain that looked good, it would not meet the breaking stress requirements. Consideration was then given to the possible benefits of heat treatment, and the practice now is to give the chain an air quench from a temperature slightly above the upper critical point.

The equipment in use at first was, of course, more or less improvised; and during the past two years there has been a constant, almost daily, development in the equipment and its use. New hammers, especially designed for this service, have been purchased, and have proved highly satisfactory in service. The methods of heat treatment have been vastly improved. Standard thermocouples have been manufactured and installed; potentiometers purchased, to use instead of galvanometers, and the use of the equipment studied, with the result that in the large, car-bottom, over-fired, chain-annealing furnace, where finished chain is treated, nine thermocouples are installed, and it is found practicable to keep the temperature variation, between different parts of the furnace chambers, within 10 degrees C.

During the fiscal year ending June 30, 1916, there were manufactured at the Boston Navy Yard practically 9 miles of chain of diameters 2¼ inches to 3⅜ inches, inclusive. No better confirmation of the statement that the problem has been solved can be asked for. The cost of 3¼-inch chain, for example, has been practically $6 per foot, or $0.06 per pound. Even this cost is considered high, because the process is not yet wholly beyond the experimental stage; that is to say, that a very great improvment will be made, probably in the near future, in the methods of bending the link, in trimming the link after welding, and in other directions, so that the cost will shortly recede to a considerable extent. Even if the cost were greater for properly made and welded chain, it would be offset by the gain in amount and regularity of production and in quality.

When the 3-inch, open-link chain for the Panama Canal was being manufactured, the cost per link, direct labor, ran about $1.37 by hand, and about $1.20 by power. The job was wound up so quickly that there was not time to bring about cost reductions; but on 3-inch, stud-link chain made for the Commission the figure of $0.86 was attained. This was subsequently still further reduced.

A brief description of the process, illustrated by photographs of the machines and their operations, is given in the paper.

It is interesting to note the economic significance of this power-forging process of making chain, as it is an excellent illustration of the division of labor which always results in the application of power for operation. Where one gang performed the operations of scarfing, bending, welding, finishing, etc., it was impossible to substitute a machine for the gang. But when the process was divided into its integral parts, then it was found that each little part was a simple one, to be done over and over again, and lending itself to the application of power. It has also this significance—that where the hand-welding process required a high-grade mechanic on each operation, this process required a high-grade mechanic on only one operation—that of welding—the other operations are so simple that a helper can be used, the helper being carefully taught the particular part of the process that he will have to perform. For example, the shearing of the bar is done by a helper; also the bending of the links is done by helpers; the upsetting and scarfing operations are performed by fourth-class mechanics, who were helpers and who have been trained to do this particular work. They were rated from helpers because the work is somewhat above that which would be normally expected of a helper.

Description and Trials of the Turbine Steam Yacht Winchester

BY E. A. STEVENS, JR.

This paper will be published in extenso in the January issue.

Discussion

Mr. E. H. B. Anderson called attention to the extreme simplicity of the machinery on this vessel. Very few auxiliaries are needed. The circulating pumps are not used when the vessel is under way, the circulating water for the condenser being supplied by scoops under the vessel, thus saving in the steam consumption of the auxiliaries. Another saving is made by arranging the turbine-driven blowers in the fireroom in series. The fuel consumption at a cruising speed of 19.7 knots gives the vessel a radius of 2,000 miles on the oil fuel which she carries.

A Theory of Fluid Friction

BY WILLIAM GATEWOOD

Abstract

The subject of fluid friction has received a great deal of attention, and empirical formulæ are in general use in connection with the flow of water, air and other fluids in

closed pipes, and with the flow of water in open channels. We have empirical formulæ also for determining the frictional resistance of vessels, derived from an analysis of experiments on flat boards. Until very recently, however, very little progress has been made in checking the accuracy of the assumptions made in extending the results of these experiments to higher speeds, greater lengths and ship-shape forms.

It seems that the reason why our knowledge of frictional resistance is so uncertain is due to the fact that there is no generally accepted theory of fluid friction. This paper is an attempt to correlate the laws of fluid motion which seem to have a bearing on the subject, and to formulate a theory.

The theory may be summarized as follows:

1. Frictional resistance per unit of surface varies as the square of the equivalent rubbing velocity determined by considering the flow to be laminar.

2. Friction between adjacent laminæ of the fluid varies as the rate of change of velocity occurring at their boundary.

3. In the case of a fixed body and a moving fluid, the frictional resistance experienced up to a given distance abaft the cutwater must be balanced by the loss of head in the wake at the same distance abaft the cutwater.

4. The width of the wake at a given distance abaft the cutwater and the reduction of velocity in the wake at various distances from the fixed body may be determined by the consideration that the loss of head outboard of any lamina is equal to the frictional resistance experienced by the lamina before reaching the given distance from the cutwater.

5. The determination of the loss of head in the wake is complicated by the condition that the volume of the fluid passing the fixed body is not altered, although the velocity in the wake is decreased. The consequent elevation of the surface of the fluid becomes of considerable importance when the velocity is relatively small or the reduction in velocity occurs quickly on account of roughness of surface.

6. The energy and action of the eddies may be assumed to be such that the loss of head may be determined as though the flow were entirely laminar.

In conclusion, it may be noted that laminar flow in the open seems hardly in accordance with all the facts as observed, since the friction of wind on water produces *waves*.

Discussion

Mr. W. L. R. Emmet described experiments which he made twenty years ago with a 25-foot toboggan boat, which he towed in a canal at speeds up to 31 miles per hour, recording the tow line pull and speed. At a speed of 15 miles per hour the waves ceased and then only friction resisted the boat, but the coefficient of friction was found to differ from that given in text books on naval architecture. Believing that this was caused by the introduction of air between the boat and the water, he suggested that possibly air might be introduced under a vessel forming foam, which will shear more easily than water and thus reduce the skin friction.

Mr. F. B. Smith called attention to the exceptional speeds obtained with lake freighters in light condition, due, he believed, to the change of trim by the stern when the vessel is under way, giving a planing effect to the flat bottom of the boat.

Notes from the Model Basin

BY NAVAL CONSTRUCTOR WM. MC ENTEE, U. S. N.

This paper is published on page 530.

Discussion

Professor H. C. Sadler called attention to the fact that these propeller experiments explain why two propellers of the same design give entirely different results. He hoped that further investigation would be made of the wind resistance of vessels.

Professor C. H. Peabody stated that while these experiments show in a marked way the results of roughness of propeller blades, they do not show the degree of loss of efficiency. They do show, however, the great advantage of having propellers finished.

Naval Constructor Gatewood suggested that a curve on the basis of thrust, showing the increased efficiency of smooth propellers, would be desirable.

Illustrated Lecture on Submarines

At the close of the Thursday afternoon session an illustrated lecture on Submarines was delivered by Mr. Eric H. Ewertz, superintendent of the Fore River Shipbuilding Corporation, Quincy, Mass.

Military and Technical Consideration of Battleship Design

BY NAVAL CONSTRUCTOR R. D. GATEWOOD, U. S. N.

This paper will be published in the January issue.

Discussion

Captain W. Hovgaard pointed out the importance of the speed-armament gage as exemplified in the present war. While there is a limit to the size of ships in the smaller navies, the limit has not been reached in vessels of the United States and other large navies. In discussing the question of size as compared with risks, he expressed the belief that risks in peace and war favored large ships rather than a greater number of smaller vessels; for in ordinary service the greater the number of ships the greater the chance for damage; while in war, although the larger ships will receive concentrated attack, they can be better safeguarded and protected. The danger from mine attack is the same for large as small vessels.

Captain A. P. Niblack stated that the size of gun depends on how far the fall of projectiles can be spotted. It is easy to exaggerate the importance of the long range of guns, because it is useless to shoot further than you can see. The matter of speed becomes a strategic question.

Professor Hovgaard stated that extreme speeds are relegated to battle cruisers, but advocated somewhat higher speeds than have been used in United States battleships before. He pointed out that on long ranges the heavier guns are more effective.

Naval Constructor R. D. Gatewood pointed out that not only can better protection be provided with large vessels, but four destroyers will be equally effective with large or small battleships, so that if there is a large number of small battleships there must be a correspondingly increased number of auxiliaries, such as destroyers, etc. He also pointed out that the 16-inch gun gives greater dispersion and that a 16-inch shell will do about one-third more damage than the 14-inch shell.

On the Suitability of Current Design of Submarines to the Needs of the United States Navy

BY CAPTAIN W. L. RODGERS, U. S. N.

Abstract

The purpose of this paper is, first, to examine the peculiar military characteristics of submarines in general and compare them with those of other types of combatant ships; second, to consider how these general characteris-

tics will influence or control the employment of submarines in war; and, finally, what particular types of submarines seem best suited to American needs.

Submarines are armed with torpedoes and with guns. Owing to the great percentage of the displacement which is necessarily devoted to the heavy hulls and very heavy machinery installation, the speed of submarines is much less than that practicable for surface craft of the same size. Consequently submarines, unlike torpedo boats and other fast craft, cannot rely on their speed as a means of safety. For the submarine the chief means of defense is provided by her submersibility and consequent invisibility. Further, the great weight of storage batteries forbids giving submarines more than a small radius of action when submerged. As the submarine when submerged cannot hope to overtake its target it must lie in wait for the target to come to it. Thus the submarine is not only an arm to be used by stealth, but its most favorable opportunities occur in dispersed and solitary action rather than in concentrated and co-ordinated action.

Until the outbreak of the current great war there seemed to be no adequate defense against submarine attack, but necessity is the mother of invention in tactics as well as in material, and there is less to fear from the submarine now than at the outbreak of the war. The great ships which the submarine would most gladly meet find their best protection is rapid motion; for the slow submarine, seeing imperfectly, is disconcerted by swift movement, more especially if this is accompanied by frequent alterations in direction. But ships cannot be always on the move and it is necessary to provide both passive defense and active counter-attack against submarines. For harbors and certain sea areas the passive defense is furnished by wire nets whose meshes are of a size suitable for catching submarines, while the counter-attack is made by thousands of swift patrol boats whose business is to destroy the submarine or force him down again whenever he comes to the surface for information or for air to start his engines and to recharge his batteries. The success of these measures against submarines is undeniable.

By a line of *a priori* reasoning the general broad conclusion to be drawn is that the submarine is essentially a defensive arm, whose use as an offensive arm, although practicable, yet partakes somewhat of the nature of a *tour de force*. So far as we know, submarines have accomplished little or nothing during the current war when acting in company with the main fleets. At the battle of Jutland last May they seem to have been absent or ineffective. The evidence of the present war as to submarines may be summarized by saying that on both sides they have obtained a degree of success in defense, to the extent of forbidding the approach of the main fleets of both sides to hostile coasts. In this successful coast defense submarines have been greatly aided by mines. The use of submarines for the purpose of strategic attack has been less successful, although Germany's attack, in particular, has arrested much attention. While the destruction of commerce has been serious, it has not led to conclusive results, although the narrow waters in which this contest has taken place have been favorable to the efforts of submarines because commerce has been obliged to cross the areas infested by them.

The geographic situation of the United States, with a very extended coast line, much of which is remote from possible enemies and borders great oceans, is very different from that of the present combatants, who are separated by comparatively narrow waters and confront each other at relatively short ranges. As we have seen, the submarine is essentially a defensive arm. It finds least opportunity when it meets its enemy in the open sea with full freedom for maneuver. On the contrary, the submarine is favored when its enemy approaches a hostile shore, where his freedom of maneuver is hampered by the proximity of the coast and his advantage of speed is thereby partially counterbalanced.

Therefore, it does not seem desirable that our navy should attempt to establish a defensive cordon of submarines far from our coasts in mid-ocean. For a line held there will be long; its distance from shore will require much time to arrive at and return from station, necessitating excessive numbers of ships. The enemy has no objective in mid-ocean and will not wait there. If he is attacked in that neighborhood by submarines he has the advantage of full opportunity to maneuver freely at high speed. On the other hand, our submarines will gain on every one of the above-mentioned points if they are used for local coast defense and do not go far off shore—say not more than a day's run. They may well expect to maintain a strip of coastal waters fairly free from the enemy and available for coast navigation, as do the English at the present time. Thus the size and type of coast-defense submarine of about 500 tons now favored by our Navy Department seems the proper and logical one for American use. American coast defense does not appear to require the largest type of submarines.

There is a great desire on the part of every navy to provide submarines capable of accompanying the fleet and taking part in general actions. For such a purpose a second type of submarine is necessary. In the present state of engineering we shall be obliged to content ourselves with a surface speed approaching the cruising speed of the fleet under war conditions, or about 20 knots. The submerged speed and radius must be very moderate; sufficient only to serve as a means of passive defense by concealment, but not enough for aggressive maneuvering while submerged. High submerged speed and great submerged radius are comparatively secondary affairs unless most radical improvements are brought about in the methods of submerged propulsion, so that high submerged mobility may be obtained without undue sacrifice of surface mobility.

The conclusion to be drawn from this study is that the Navy Department has made a judicious decision in the combination of military characteristics which it has embodied in its latest designs of submarines for service with the fleet as well as for coast defense.

DISCUSSION

Captain W. Hovgaard pointed out that larger boats are more seaworthy and are consequently more habitable for crews on long voyages. He concluded at variance with the author's opinion expressed in the paper that submarines of 800 to 900 tons displacement were needed for defensive and offensive warfare.

Rear Admiral Grant, in a written discussion, believed that the offensive warfare of submarines was the more important, and that the vessels of 500 tons displacement as adopted by the United States were not suited to offensive warfare.

Naval Constructor T. G. Roberts advocated the conclusions of the author, stating that there is but one good reason for 800-ton vessels and that is high surface speed. As a matter of fact a speed of only 17 knots would probably be obtained. He concluded that for coast defense, submarines of 530 tons, such as are now being laid down for the navy, are the best type of boats.

At the beginning of the Friday afternoon session, 23 new members were elected to the Society, and, at a suggestion communicated by Colonel Stevens, it was voted

to authorize the Executive Committee to appoint a committee to draw up a code of professional ethics for naval architects.

Naval Stations and Naval Bases

BY CAPTAIN A. P. NIBLACK, U. S. N.

ABSTRACT

It is important that this country awaken to its strategical requirements in the Atlantic, Pacific and Caribbean, and, as the principles governing the selection and outfitting of naval stations and naval bases are not generally recognized, it is the purpose of this paper, as briefly as possible, to touch on the elements of the problems awaiting us. To outline our peace strategy, let us assume that, among all our navy yards and stations on the Atlantic coast, our two main bases, to be decided upon, are, say, New York and Norfolk. New York, as the assumed center, and Boston and Philadelphia on the periphery of the circle enclosing the main industrial area of the United States, become the true strategical center the instant we deepen the Cape Cod and the Delaware and Raritan canals into ship canals, clear the East River of all obstructions from the Battery to Long Island Sound, and adequately fortify Block Island, Vineyard Sound, Buzzards Bay and Cape Cod Bay regions. With exits at Delaware Bay, Sandy Hook, Block Island, and Massachusetts Bay the entire British Navy, as it exists to-day, could not contain our own navy as it is, although it is continually able to contain a much larger and more powerful one, the German Navy, even with the two exits it has by virtue of the superb Kiel Canal. Our "Heligoland," Block Island, is now only a summer resort, but, defended as it should be, it would be the armed sentinel at the gate. The region around New York, of which we speak, represents billions of dollars, and the expense of providing mobility to our naval forces and security to the area would be but a fraction of one percent. As a mere commercial proposition the enlarged waterway would pay without the guns and mines to secure it, in case of war, and the present serious trend of public opinion makes the whole question one of easy possibilities. The defenses of Cape Cod Bay, Narragansett Bay, New York Bay and Delaware Bay are one and the same question, and the area from Boston to the Delaware Breakwater is our main strategical area.

Our second considerable strategical area is that of Chesapeake Bay, embracing Washington and Norfolk—that is, the national capital and an immensely important naval base. It is far along in our plans to speak of the very desirable proposition of the Delaware and Chesapeake Canal as a ship canal, but it is easy enough to see what it would add to the mobility of our naval forces and to the security of our coasting trade in case of war. Just now the adequate defense of Chesapeake Bay entrance is the main consideration for we have left that "stable door" wide open, as we have also the Delaware Bay entrance. It is therefore idle to talk too much theory when our practice is so elementarily careless.

The first commanding strategical point, in connection with the Panama Canal and its approaches, is Key West. In considering the defense of the approaches to the Isthmian Canal route in the Atlantic and Caribbean, the most striking fact is the commanding position of Great Britain, with Bermuda less than 700 miles from Cape Cod, Sandy Hook and Cape Henry, and with the Bahamas, Jamaica, St. Lucia, Barbadoes and Trinidad commanding the approaches to the canal from all directions. While we all habitually assume the benevolence of British policy toward us, it is not a justifiable strategic assumption. One should not leave his business affairs entirely in the hands of anyone else, if it can be avoided. Fortunately we already possess the necessary positions to secure the approaches to the Caribbean against all comers, and all we need is the sagacity to add to the strategical positions the necessary strength, resources, and mobile defenses to make them good. We have the tactical defenses of the Panama Canal itself well under way and well understood; and we have Guantanamo "on the mainland," dominating Jamaica and the Windward Passage; but we have over and beyond all Culebra Island, the neutralizer of Bermuda and the British West Indies positions—the ideal outlying strategical base—situated 20 miles east of Porto Rico and 20 miles west of the Danish island of St. Thomas. For the price we could possibly purchase the Danish West Indies we could make them useless strategically to anyone else by spending the money on Culebra, only 20 miles distant from St. Thomas.

Almost every drawback that may be glibly cited against Culebra as our great naval base for our fleet in the Atlantic is really an advantage. For instance, it is usually argued that the island and its harbor are too small, whereas, if anything, the island is too large, and the harbor could be even smaller before it would cease to be ideal. Of course it is out of the question to expect to find a ready-made naval base, and we are in luck to have all the treasures we have. There is, above all, no question of Culebra versus Guantanamo, because the latter merely supplements the former. There may be a Culebra without Guantanamo, but no Guantanamo without a Culebra, because Guantanamo is on the undefended mainland, and, with Culebra securely held, it would be on the flank of an attacking expeditionary force operating against Guantanamo.

On the Pacific coast we recognize the importance of two home bases, one on San Francisco Bay and the other on Puget Sound, and so it remains to consider the question of outlying and advance bases in the strategy of the Pacific. Any consideration of the strategy of the Pacific is utterly futile which leaves out the erection of Guam into a great naval base as our key to it for all time—our far-flung outpost of "peace in the Pacific" through armed power in repose. Other positions which we now own, such as Tutuila (Samoa), Dutch Harbor (Unalaska), Sitka, Midway Island, Corregidor, etc., are questions of definite offensive or defensive areas, or of shortening lines of communications, and as such are worthy of consideration as strategic points, but our first necessity is the extension of the defenses of the Panama Canal and Pearl Harbor. Then come Culebra and Guam as great insular bases.

We require naval stations and naval bases to correspond with our policies, with our strategy, and with the requirements of our fleet. It means the expenditure of millions of dollars and is the price of that empire which is ours by destiny, by geography, and by the blood this nation has already shed, but which empire will surely crumble if we sit back.

That preparation in time of peace can only be called adequate which leaves only mobilization as the remaining step in strategy if war unhappily comes. We know what our resources and land and sea forces are, and also those of other nations. We know what our own and other nations' policies are. Our strategy must fit what we have, and if we have little we can do little.

Refrigeration and Refrigerator Insulation on Board Ship

BY ROBERT F. MASSA

ABSTRACT

In insulating refrigerators "built in" on board ship, the best construction, according to the writer, is the use of pure sheet cork cemented with a special cement directly

to the steel surfaces forming the compartment. The second course of cork is set in asphalt after the first course has been carefully pointed up with an asphaltic cement mixed with fine regranulated cork. In this way all possibility of air spaces is eliminated and the chance of any moisture accumulating is avoided. The inside surface may, in this case, be finished in cement, although in some classes of work the cement can be omitted and an asphalt finish used instead.

Difficulty has been encountered with the use of cork that had not been sufficiently pressed previous to baking. This cork was not as dense as it should have been and had not the mechanical strength it should have had. More or less air spaces were left in the cork, into which there was, of course, the tendency for moisture to penetrate, and where the temperature was very low this moisture froze and pried the sheets apart, completely disintegrating the insulation and requiring that the entire work be done over again.

The idea seems to prevail that a refrigerator door should have beveled edges and that these beveled edges make a very tight door. As a matter of fact, such a door can be tight only if it happens to be very carefully fitted. As soon, however, as the moisture begins to have its inevitable effect, the door cannot by any chance be tight. Furthermore, if the hinges yield at all, as they are certain to do with a heavy refrigerator door, it will never be tight, even though it does not warp at all.

In the writer's opinion there is only one practical way to make a tight refrigerator door; that is, to have a plane surface come up against a plane surface with a flexible gasket between these two surfaces. It may also be possible to have a pair of such surfaces, or, rather, two pairs of such surfaces with gaskets between them, making an air pocket between the two seals. If this arrangement is used the door can sag considerably without causing any serious binding or failure in tightness.

In estimating the capacity of a refrigerating machine required for taking care of a given refrigerator, it is not sufficient to calculate the heat loss through the insulation of the refrigerator. This loss in many cases is very much smaller in proportion to the total loss than the average engineer realizes. Heat enters a refrigerated compartment through five avenues: First, through the walls, i. e., through the insulation; second, in warm goods; third, by the interchange of air through the opening of doors and by air leaks through defective insulation or through defective doors, cold air being heavier and immediately flowing out when doors are opened; fourth, from lights or from the heat of the bodies of workers; and fifth, from any change of state occurring in the goods, such as freezing, fermenting, etc. In large rooms these various losses of heat should be analyzed separately. In small refrigerators a rough rule that gives quite as accurate result as a more elaborate analysis allows for a certain number of British thermal units per cubic foot of refrigerator per twenty-four hours. In general, the size of machine for a given refrigerator has to be decided upon before the refrigerator is put into service. On the other hand, where an existing ice-cooled refrigerator is to be cooled mechanically, one check on the size of the machine required is given by the amount of ice which has been used. This check is, however, more likely than any other to lead to wrong conclusions unless the figures are properly analyzed.

The best arrangement of cooling surface in the refrigerator is either to place it in a loft above the box—i. e., above the storage compartment, or in a space alongside of this compartment, with ample air passages to permit the circulation of the air between the two compartments. This arrangement is, of course, inefficient as regards the use of the cooling surface, but gives a very much more satisfactory refrigerator. Moisture is deposited on the coils, the air passes back to the refrigerator partially dried, and, if the box is properly proportioned, the air in passing over surfaces of the refrigerator, as well as over the goods, dries them and keeps them in good shape.

The writer also calls attention to a few of the considerations that seem important in determining the type of machine suitable for any given installation.

The Resistance of Various Types of Barges in Shallow and Deep Water

BY PROFESSOR HERBERT C. SADLER

ABSTRACT

The subject matter of this paper represents a digest of the results of a number of experiments on various types of barges, originally undertaken for the "Board on Experimental Towboats," U. S. Army. A full report in somewhat different form was published as Document No. 857, House of Representatives, Sixty-third Congress, Second Session, but is now out of print. In the original report, the results were worked up for a particular size of vessel (150 feet long). In order to make them more readily applicable to any size, the curves have been replotted in terms of residuary resistance per ton of displacement on a speed-length ratio base (V in knots; L, length over all, in feet; R_w in pounds; displacement in long tons). The wetted surface, and hence frictional resistance, in the different types varies somewhat, but may easily be calculated for any specific size. So far as relative results are concerned, the inclusion of this does not appear to affect the standing of any particular type materially.

In all, nine different forms were tried, the bows and sterns being the same in all cases. They cover variations of "rake" forward and aft, shape of side, and shaped versus flat forms. The middle body in all cases was box-shaped with square corners. The models were all tried at the same two displacements for each type, corresponding to the "load," and "light," or 55 percent of the load displacement. Each model was tested in four different depths of water, or corresponding to a vessel 150 feet in length, these would be 6 feet, 9 feet, 12 feet, and "deep water."

In the shallower water resistance curves tend to arrange themselves into two groups; the forms with the straight sides having, on the whole, greater resistance than those where the sides are curved. The ship-shaped form is uniformly good, but it is followed closely by the scow form. The flat-iron shape with vertical sides appears at its best in very shallow water, otherwise it does not seem to be as good as some of the others. The models with long rake are easily driven forms, but do not have the same amount of displacement at the load draft as the others. The effect of square versus round corners may be seen by comparing these two types. The form with the circular end shows up fairly well in very shallow water, as it is the one of greatest displacement and consequently floats at a lighter draft. In fact, the clearance between the bottom of the vessel and that of the river appears to have a marked effect in the resistance of any form.

In deep water the forms arrange themselves in somewhat the same order, the straight-sided ones having larger resistance than those with curved sides, and those with "easy" rakes less than those with the steeper rakes.

Some additional experiments were made with the same shapes of ends and sides, but with smaller beam. The resistance per ton of displacement for all practical pur-

poses appeared to be constant, or, in other words, the resistance varied about as the beam within the limits of speed for vessels of this type.

All the above forms were tried in groups of six, two abreast and three deep, and certain selected forms in groups two, three, four and five. In all cases the models were lashed close together, corresponding to the common practice in this country. Some of the forms with straight sides show relatively better results when grouped together, due probably to the fact that they present perfectly flat sides and no spaces between, whereas with curved sides offer places for the creation of extra wave-making resistance. In deep water the resistance per ton decreases slightly as the number of barges is increased. In shallow water, by adding one extra barge in front, either in the three or five combination, the resistance is actually decreased as compared with two or four barges. In other words, it is actually more economical to increase the load 50 percent in the case where two barges are towed abreast. The explanation appears to be that the extra barge acts as a "bow" to the others and reduces the wave-making resistance, both by increasing length and reducing head resistance.

In general it may be concluded that, although the ship-shaped form is perhaps the best, taking all things into consideration, a form with a moderate rake and curved sides, is practically as good, and when simplicity of construction and repair are taken into account, the latter form is to be recommended.

Feathering Paddle-Wheels

BY PROFESSOR E. M. BRAGG

ABSTRACT

In the year 1913 tests were made in the model basin of the University of Michigan upon certain models of radial and feathering paddle-wheels. These tests were made for a board of army engineers appointed to investigate the question of towboats and barges for the Mississippi River. The complete report upon the subject can be found in House Document No. 857, entitled "Experimental Towboats."

Since the publication of the above report I have taken the results for feathering wheels and plotted them in a more compact form and have compared the results obtained from the model wheels with those for full-sized wheels.

While it is not the purpose of this paper to discuss radial paddle-wheels, it may not be out of place to call attention to some of the differences which exist between the two types of wheels. The radial paddles give more thrust than the feathering for the same slip, but work at a lower efficiency. The radial wheel has its maximum efficiency at about 10 percent slip, while the maximum efficiency of the feathering wheel occurs at about 15 percent slip. The efficiency for both types decreases with increase of dip but the decrease is less for feathering blades than for radial blades.

The object of the model tests was to determine the best proportions for stern wheels on boats of moderate speed. The dip ratios used were between 1 and 1.5. In applying these results to side-wheels on boats of rather high speed it was necessary to extend the curves to dip ratios of 2.5. This was done on the assumption that the maximum thrust would occur when the wheel was immersed to the center and the thrust would be approximately zero when the wheel was fully immersed. The efficiency curves were extended on the assumption that when the wheel was fully immersed the efficiency would be approximately zero.

The pitch ratio is the ratio of the distance between the trunnions, measured on the arc of the circle, to the width of the blade. Curves showing how thrust and efficiency vary with this factor indicate that as a rule it would be better to sacrifice a little thrust in order to gain in efficiency. If a blade-width ratio of 0.16 is used, a pitch ratio of 1.85 would call for 9 blades, while a pitch ratio of 1.5 would call for 11 blades. At 15 percent slip the unit pressure at pitch ratio 1.85 is 1.6 pounds and the efficiency is 0.668, while at pitch ratio 1.5 the thrust is 1.66 pounds and the efficiency is 0.64. Each of the 9 blades would have to be 4 percent larger than each of the 11 blades, but the efficiency would be a little over 4 percent greater, and the total blade area would be about 86 percent of the 11-blade wheel. Some designers use a large number of blades to reduce vibration.

An attempt has been made to correlate the results obtained from model feathering wheels with the trial trip results of full-sized wheels. It is obvious that the location of the wheel relative to the bow wave is going to influence the working of the wheel to a large degree. In the determination of the wheel location relative to the crest of the bow wave it was assumed that the length of the wave created by the passage of the boat would be $.5573\ V^2$ and that the first crest would be 12 percent of the wave length aft of the bow. V is the velocity of the boat in knots.

The maximum quantities do not occur at the wave crest but a little aft of it. This seems plausible when it is considered that the blades enter the water some distance forward of the center of the wheel and it is the first part of the stroke which is most effective. Also the wheels have considerable length, and the wave crests are not parallel to the axis of the wheel but rake aft. Another possibility is that the wave crest is more than 12 percent aft of the bow.

The model wheels, when tested in the tank, were not adjacent to the hull of a boat, and by reason of this condition the dip observed when at rest would be very close to the dip when in motion. The apparent slip and true slip of the model wheel would be practically the same. The only condition tending to affect these would be the velocity of approach of the water to the wheel, which would be very small.

The paddle-wheel of a side-wheel boat is working under quite different conditions as regards dip and slip. The velocity of approach would be somewhat larger, due to the proximity of the hull. Due to the passage of the boat through the water there will be stream-line flow, wake and waves.

The dip of the blades when the boat is in motion may differ considerably from the dip when at rest, depending upon the part of the wave in which the wheel is working. The true slip of the wheel will differ from the apparent slip because of the velocity of approach, wake, stream-line flow and orbital motion of the water in wave formation. If the wheel is working in the hollow of the wave, all of these except the wake make the true slip less than the apparent slip. If the wheel is working in the crest of the wave the wake and orbital motion are opposed to the stream line flow and velocity of approach, and the true slip is probably greater than the apparent slip. It would appear, however, that the change in slip is much less in degree than the change in dip.

In addition to this uncertainty regarding the true slip and true dip of the full-sized wheels, there is further uncertainty regarding the variation of thrust with speed of advance. The usual assumption is that the thrust varies as the square of the speed of advance. The models were all tested at a speed of advance of 100 feet per minute while the full-sized wheels were moving at a velocity of about 2,000 feet per minute. The model

wheels were practically 1 foot in diameter, while the full-sized wheels were from 25 feet to 30 feet in diameter. According to the law of comparison the corresponding speed for the full-sized wheels would be about $100\sqrt{30}$, or about 550 feet per minute. The full-sized wheels were advancing at speeds which were three to four times the corresponding speed.

With these three unknown conditions—namely, the variation of thrust with speed of advance, the variation of true dip from the observed dip at rest, and the variation of true slip from the apparent slip—it can be readily seen that there are a large number of relation factors which might be derived, depending upon the assumptions made regarding one or all of the unknowns. In the paper are given only two relation factors, one which is called the virtual slip and one the virtual dip.

Alquist Gearing for Ship Propulsion

BY W. L. R. EMMET

This paper is published on page 536.

Electric Pumping Equipment and Notes of Interest on Union Oil Company of California's Tank Steamer La Brea

BY HUGO P. FREAR

This paper will be published in the January issue.

The Commercial Gyroscopic Compass

BY ELMER A. SPERRY

Abstract

With the advent of the gyro-compass for navigational purposes, there was introduced for the first time an instrument of precision whereby courses could be laid with great accuracy, and dead reckoning computed with an exactitude theretofore impossible. The compass incorporates as an essential feature an indicator of its true meridional bearing. With the gyro-compass there is never any necessity for swinging the ship. Within the last four years a large mass of data has been accumulated of the performance of the gyro-compasses upon practically all of the "seven seas." These records agree in demonstrating that in the gyro-compass we have an instrument entirely free from all of the difficulties and disturbances to which the magnetic compass is subject.

The field of force utilized and upon which the new navigational instrument depends for its directive power is the actual rotation of the earth. This angular motion, although it occurs about an axis some four thousand miles distant, through a well-known gyroscopic phenomenon, compels the gyro wheel to set its spinning axis parallel with the axis of the earth. The earth's rotational force is so impressed upon the gyro as to cause this phenomenon to take place with the greatest exactness, so that it may be employed as a navigational compass of high precision. The phenomenon being a terrestrial one, the pointing is upon the true geographic meridian, which is identical with that utilized in navigation; therefore, when the compass is properly organized, no deviations or variations exist to complicate its use.

The reason for the high precision of the gyro-compass lies in the fact that, in addition to its true meridional pointing, its tenacity of purpose or directive power is many times that of the magnetic compass. The directive power of the new commercial compass is about one hundred and fifty times that of the same standard navy magnetic compass, in the positions occupied in both naval ships and those of the merchant marine.

In the gyro-compass equipments using repeaters, a secondary transmission system is employed. This comprises a transmitter, operated by and forming part of the master compass, and various forms of repeating instruments, controlled by the transmitter, but located at distant points about the ship. The transmitter is power driven by the compass and is also connected with the automatic correction device in such a manner that only corrected readings of the master compass are transmitted to the repeaters, which thus read in true bearing on the meridian. Repeaters, which indicate the true headings of the master compass, may be located wherever desired on the ship. Various other devices, such as azimuth indicators, recorders, automatic latitude instruments, ordnance appliances, automatic steering mechanism, etc., may be operated from the same circuits that supply the repeaters.

All repeating instruments are positively driven by especially designed step by step motors, which have no moving contacts in circuit. These instruments follow the movements of the master compass with a maximum error of about 1/12 degree and a lag of about 1/100 of a second. Less than ten watts of energy are consumed for each instrument, yet the card is driven with as high a torque as 10,000 gm. cms., which abundantly insures the instruments against derangement from shock of gunfire.

Not only is there an entire absence of variation and deviation in the Sperry gyro-compass, but extended experience at sea shows that there is no heeling error even in the heaviest rolling, this being true for all headings.

The new compass for merchant ships is smaller and lighter than the battle gyro-compass, and is being developed in a still smaller form for use on aeroplanes and small yachts. As built at present, it weighs only about fifty pounds, exclusive of the binnacle in which it is mounted, the complete weight with the binnacle being only about 225 pounds. The smaller size will weigh only about 40 pounds when the aeroplane mounting is used, there being no binnacle. The overall diameter of the compass with the binnacle is only about 16 inches, and the weight about 100 pounds. Due to the small size of the wheels (the wheels used on the destroyer type are only five inches in diameter), the time required to bring the compass up to speed from rest is only about five minutes.

Three standard compass equipments are supplied. The simpler equipment consists only of the master compass, motor generator, and a very simple switch panel, while the larger equipment contains in addition a pelorus stand, storage battery, two repeater compasses, and a larger switchboard, one panel of which is to care for the repeater compasses. These equipments are being installed on the secondary naval ships and the larger ships of the merchant marine.

Another equipment is also provided in which the pelorus stand is omitted and a switchboard intermediate between the two illustrated is supplied. The entire master compass operates on alternating current, and in the case of the equipment where no repeater compasses are used, the motor generator simply converts a slight amount of the ship's supply of direct current into alternating current of the proper voltage and frequency. The generator operates automatically. The repeater compasses, however, operate on a low voltage direct current, and the motor generators for these equipments are extended on one end and serve also to generate the slight amount of low voltage direct current required. In these equipments a storage battery is also provided, and arrangements are made so that, in case of failure of the ship's supply, the entire compass equipment will be automatically transferred to the storage battery, which has sufficient capacity to carry the entire equipment independently for a period of two or three hours.

Not only can the gyro-compass actuate the automatic helmsman, which holds the ship with great precision and minimum help, but it may also operate a recorder, which makes an automatic record of every change of heading, however minute, recording the exact moment of such change; thus giving a continuous and accurate record of the heading of the ship. This instrument is incidentally useful in obtaining the characteristics of different helmsmen, and its records are of the greatest value to the navigator, especially when observations are impossible—navigating by dead reckoning.

NAVAL ARCHITECTS' BANQUET

The annual meeting of the Naval Architects' Society was brought to a close with a banquet at the Waldorf-Astoria on Friday evening, November 17. Stevenson Taylor, president of the society, presided. The speakers included Rear Admiral Nathaniel R. Usher, U. S. N., who spoke on preparedness; Bernard N. Baker, who discussed the shipping board in its relation to the American merchant marine; Charles Sherrill, who discussed the modern Monroe Doctrine; A. L. Thurman, who spoke on the marine work of the Department of Commerce, and G. E. O'Dell, whose subject was "Is the Doctrine of Equality Played Out?"

NEW BOOKS FOR MARINE ENGINEERS

THE MECHANICAL HANDLING AND STORING OF MATERIALS. By George Frederick Zimmer, A. M. Inst. C. C. Size, 7¼ by 10 inches. Pages, 752. Illustrations over 1,000. New York, 1916: D. Van Nostrand Company. Price, $12.50 net.

REVIEWED BY H. MCL. HARDING *

The subject of mechanical handling and storage of material is one which now appeals most strongly not only to all manufacturing industries, but to transportation interests and to every engineer, whether civil, mechanical, electrical and especially to all terminal engineers. While there are a few treatises on this subject, yet one that is authoritative and embraces the latest developmens and improvements is the only one of practical usable value. Otherwise a supplanted machine or an ancient method might be accepted as being the best.

The contents of this book will be found satisfactory to all who have had occasion to consult such a work for complete and precise information. Improvements in mechanism and methods are being made daily and the last machine is often the one which, if adequately described, would be adopted.

As to the different types of conveyors, the tables, giving data as to sizes of the parts of the various conveyors with the speed, tonnage and bushel capacity per hour, will be of great value to all mechanical engineers. The diagrams are exceedingly clear and give that information which is always wanted and is so often omitted. Full appreciation by the author of the value of a properly annotated index is immediately evident.

TRADE AS A SCIENCE. By Ernest J. P. Benn. Size, 7½ by 5 inches. Pages, 184. London, 1916: Jarrold & Sons.

Although this book is published to stimulate the enthusiasm of the British public in the subject of trade and to bring about more scientific methods in the handling of trade, it will be exceedingly interesting to American readers, for the subject of trade is discussed in a very earnest and comprehensive manner. In many respects it is brutally frank in the way it exposes British weaknesses in trade and business in general, and such frankness cannot fail to be helpful in bringing about a more systematic method of carrying on British trade after the war. The book contains much that will be of interest to Americans; for, although Americans may have some advantages over other countries, they are undoubtedly weak in many respects, and should not hesitate to learn where trade plans can be strengthened.

It will surprise many Americans to learn from this book the lack of co-operation among British business men. That the average Britisher is an excellent business man cannot be questioned, and anyone who has had experience with him cannot fail to admire his splendid integrity, which is probably not equaled by any other nation. His great weakness seems to be that he does not want to co-operate with others, particularly in his special line of business. Instead of being proud of his business and saturated with ambition to build it up and strengthen it, making a record each year over the previous year in efficiency and success, he is more given to keep under cover the fact that he is in business.

If British people benefit even partially by what is said in this book, we may look for a greatly strengthened foreign trade in Great Britain as soon as the war is over.

* Consulting Engineer, New York.

THERE AIN'T NO NEWS

A Story of the Water Front

BY FRANCIS KEY

"Cap, what's the news of the Nancy Ann?
Tell me the news, mister, if you can."

"We are just in from around Biscay,
But there ain't no news for you to-day.
Our ship was blowed on the rocks by squalls,
And the crew was et by cannibals.
But there ain't no news."

"Oh, mister, can your ship go some?
Was she built to go, or built to come?"

"This ship, me lad, is so full of speed
That she goes so fast the crew can't feed.
When we left Biscay the other day
We went so fast that we boiled the bay.
But there ain't no news."

"Oh, mister, have you seen any storms,
Any U-boats, serpents or fearsome forms?"

"No U-boat, lad, have we seen, by heck!
Or else we'd beat 'em across by a neck.
A lad's aboard with a wild harpoon,
And playin' U-boats is his favorite tune.
But there ain't no news."

"Oh, Cap, is your wife aboard the ship?
Did you bring your children on this trip?"

"My wife's at home—where she ought to be—
For women, y' know, don't like the sea.
Besides, me lad, 'tis a pleasure trip,
And I've a flask in my starboard hip.
But there ain't no news."

—From the New York Herald.

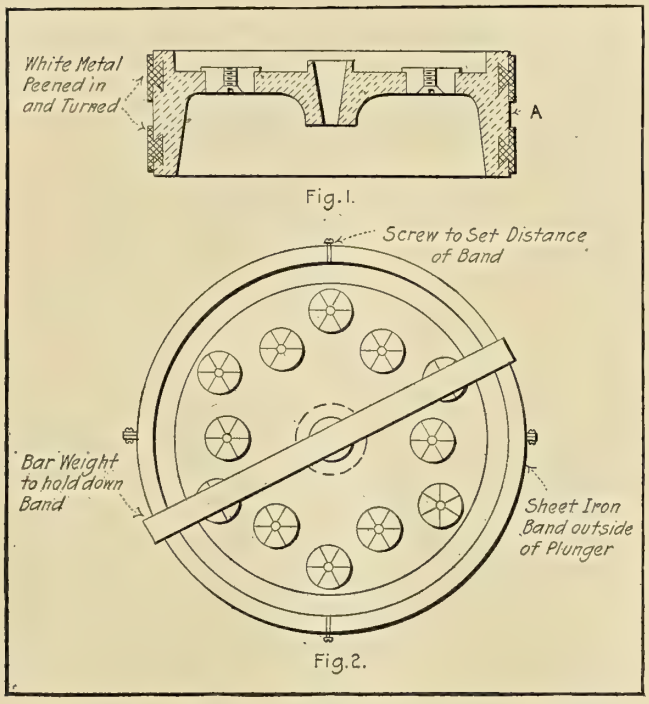
Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Economical Repair to Worn Plunger in Main Air Pump

When the plungers of air pumps and the cylinders become worn and out of round, there is caused a loss of vacuum. Recently, after great efforts in locating and stopping small leaks of air into the system, with very little effect on our poor vacuum (24 inches), we decided to examine the bores of the air cylinders and the fit of



Section of Worn Plunger, Showing Method of Repair

the plungers. It resulted in finding that they were considerably out of true in their circumferences. Very nearly 3/64 inch opening all around the plunger was shown by the use of feelers, and when the cylinder walls were calipered they were found to be 1/16 inch out of true at the largest diameter. The plungers averaged the same.

These conditions really called for either renewal of the liner of the cylinders and truing up the plungers, or reboring and new or built-up plungers. Either of these repairs would have been expensive for this vessel when it is considered that she is fifteen years old and her machinery in very poor condition. Therefore a repair was made as shown in the accompanying sketches.

The plungers were placed in a lathe and trued up. This reduced their diameter, and dovetail grooves were turned in the face as shown. A sheet iron band one inch larger in diameter than the plunger was made in two pieces and bolted together with a gasket between the joints. A piece of flat boiler plate was found large enough on which to set the plunger. A bed of fire clay was mixed up and spread around this plate in a circle wide enough on which to bed the plunger and the sheet iron band, as shown in Fig. 3. Four regulating screws were put in around the circumference of the band at the center of its height to equalize the space between it and the plunger. The plunger and band were placed on this bed of fire clay and the clay tamped up tight on the inside of the plunger with a small rod worked through the valve seat holes, and at the bottom of the space between the band it was tamped down hard, crowding it under the edge of the plunger. The plunger itself, being heavy, made this a good joint. A heavy bar was laid across the top of the band to keep it down hard in the clay. This completed the mold.

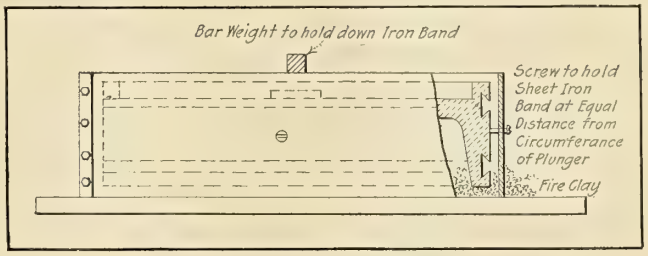


Fig. 3.—Mold for Pouring White Metal

White metal was melted and poured into it, pouring from two big ladles the metal melted in a crucible on a hand forge. When cold, the band was removed and the white metal then peened in with a ball peen hammer.

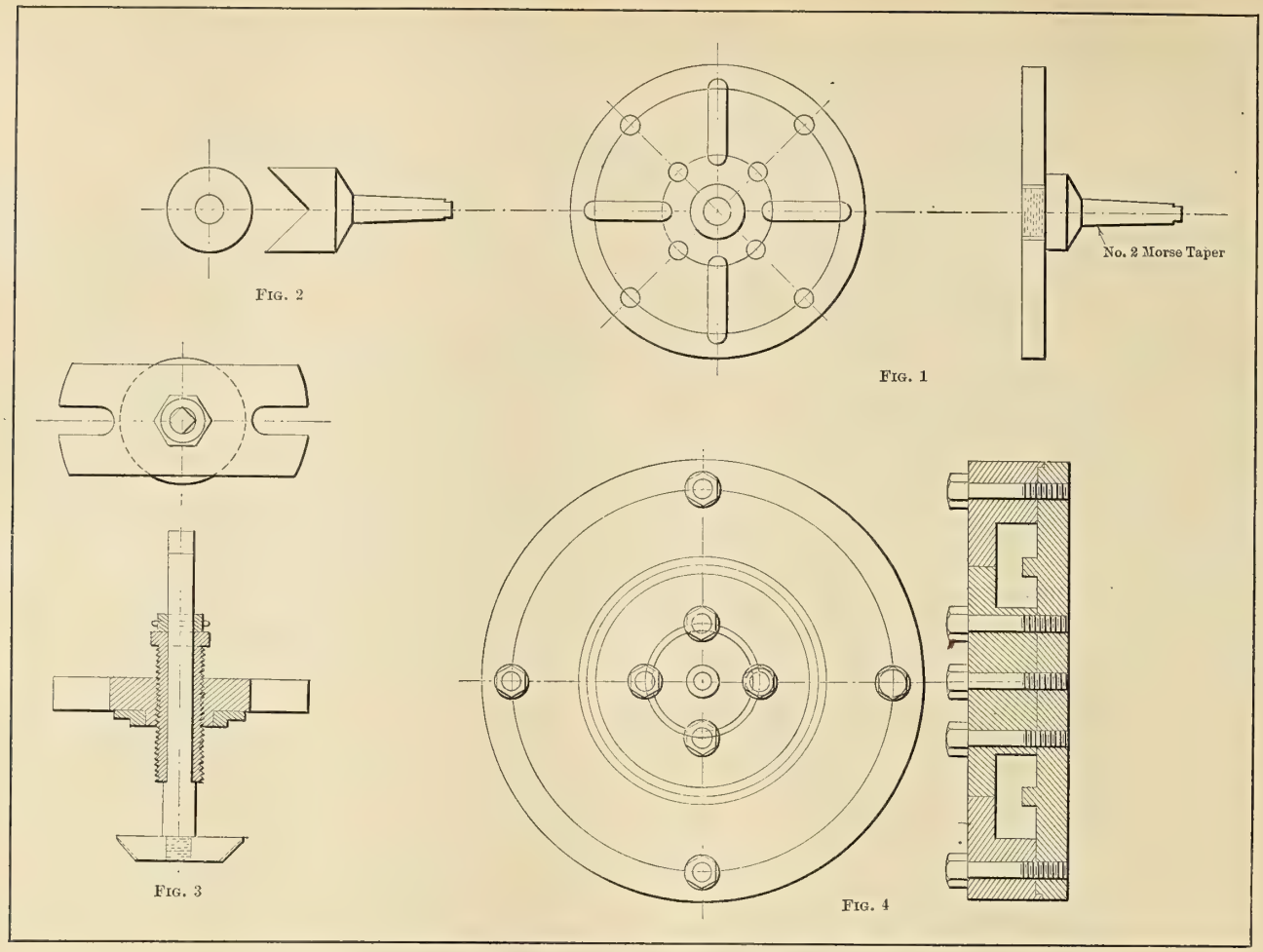
The plunger was then placed in the lathe and machined as shown in Fig. 1 to a little larger than the large diameter of the cylinder—about .015 thousandths. It was then scraped and rasped off with a course rasp until it fit the bore of the cylinder in the position in which it was to operate, it being secured against turning by pins in the piston rod at the crosshead and at the shoulder on the plunger where the rod fits the taper. The space between the two rings of babbit or white metal at *A* in Fig. 1 formed a water seal at each stroke.

The result at the completion of the test was very pleasing, for we obtained 28.5 inches of vacuum. The pumps have been operated through some 16,000 miles of steaming and still hold up 28 inches with a fairly moderate speed of operation. The work was all accomplished on board ship and the time required was five days to do two plungers of a twin air pump. C. H. W.

Some Economy Kinks

On taking charge of a bay steamer some time ago I found rather a poor tool equipment. We were soon provided with ratchets and drills and bolt and pipe threading tools, hammer, chisels, files, etc., so we were not quite dependent on the shop, but I think every boat that has room for its installation should have a lathe. As we had plenty of room in the shaft alley and a 1-horsepower motor in the kitchen that had been installed for a dish washer, but was not used for that or any other purpose I suggested that we install a lathe.

The suggestion was adopted and we got a light 13-inch



Economical Repair Jobs—Turned Out on Board Ship

lathe and an 8-inch emery wheel which, with a countershaft and the motor mentioned above, gave us a fair shop outfit. The convenience of the thing and the economies we have been able to effect have been surprising. The whole outfit entailed an outlay of less than $200 (£41.1), and it had more than paid for itself in the first year it was used. By means of this shop outfit we are able to keep up the auxiliary repairs at practically no outside shop expense. We make our own piston and valve rod packing for the main engine, turn up our valve disks and stems and reseat the valves, make our small rods and bushings, pump valve guards, glands, rings, etc.

On of our first jobs was to make the plate fitted to the taper shank shown in Fig. 1. This we use in the tail stock when drilling flate or irregular parts. When drilling round parts we use the V block (see Fig. 2), which was the result of our next effort along this line. Later we made the reseating machine, Fig. 3, which answers our purpose quite as well as the more expensive patent machines.

We designed and made this complete, except cutting the teeth in the cutters, which we had done on a milling machine. We made bushings and cutters, adopting the machine to the different sizes of valves for which we use it, which are mainly the boiler feed stop, check and blow-off valves. Note that the feed screw has a left-hand thread. If the screw should stick and turn with the spindle it will feed away from the valve seat, thus not digging into and spoiling it.

On the main engine we use metallic packing. The white metal rings are cut in two, three or four pieces, and are held against the rod by a spiral spring, which is carried in a groove on the back of the ring. The rings are carried in a series of cast iron cups, each cup carrying two rings, four cups making a set for a rod. When we came to renew the rings we found it a rather expensive proposition, so we decided to try our hand at making them.

We made a cast iron mold in which to run the white metal casting, which we made 6 inches long, allowing material inside and out for boring and turning. We then rough turn and bore and cut off the rings, cutting the groove in the outside to provide means for clamping them to the face plate. We then clamp them to the face plate and finish both sides, bringing them to the exact thickness required (micrometric measurement). We then cut them with a cold metal saw, the saw running on a mandrel between the lathe centers and the ring, being held between clamps on the tool post and fed into saw with the cross feed; all of this equipment is "home made" except the saw. The rings are then clamped in the jig, Fig. 4, and finished to the exact required diameter, the center cap being removed for boring, after which the center cap is replaced and the outer one removed for finishing the outside. The result is a ring fitting the rod perfectly and the ends fitting together nicely at the joints.

Neither the number of pieces in which the rings are cut, nor the exact angle at which the cut is made, seems to affect the results very much. We have tried cutting them in two, three and four pieces and got good results with all of it, finally adapting the three-piece ring.

Something else that gives us very little trouble is the alloy of which they are made. We began using 83 1/3 lead, 8 1/3 tin and 8 1/3 antimony. This gave a rather soft metal, though we got very good service with it. Later we increased the percentage of antimony. As we use the

old metal over, it would be difficult to say just what we are using at present. A superintending engineer told me some time ago that his people were using their old bearing metal for rod packing, so I have decided that the exact composition of packing metal is not by any means a vital point, the metallic packing salesmen to the contrary notwithstanding.

For small rods and stems and check and stop valve stems we have got very good results by mixing bird shot, assorted sizes, fours to nines, with pulverized graphite and pulverized mica, with just enough oil to hold it in a mass. It works best when stuffed into strings like frankfurters, though we frequently use it without that preparation. We have used nothing else on our boiler stops and checks for about two years, and it is the only packing we have ever used on our dynamo engines that would hold and not wear the rods rapidly.

D. SAWYER,
Chief Engineer, S.S. *Northland*.
Norfolk & Washington Steamboat Company,
Norfolk, Va.

Stops Valves

Many have been the accidents due to steam valves and the omission of any indication as to their open or shut condition. Many lamentable happenings have been averted only by narrow margins due more to good luck than sound judgement. So long as valves are fitted giving no reliable and positive indication of their adjustment, so long will the opportunity exist for causing danger to life and personal risk by wrong manipulation of the hand wheel in perfect good faith. Two instances in the writer's experience point their own moral, and if damage did not result it was not from lack of opportunity.

The main stop valves in a certain steamer had been overhauled in port, valves examined, ground in and glands repacked. The engineer responsible omitted to see that they were definitely closed, or else opened them full in mistake. Fires were subsequently lighted and steam raised slowly during the whole night. No one troubled about the job until it was decided to warm up the engines a few hours before the tide served. To the amazement of the engineer on anchor watch, the engines were found warmed up with full steam on. No water having been circulated through the condenser, which was found red hot, hasty test failed to locate a leak, but the consequences of the open valves could have easily been serious enough and might have involved a cracked condenser and considerable delay to sailing.

To this day the writer marvels that no one noticed the condition of the engines, but as they had had a lengthy overhaul, the rod glands were tight, having been repacked so that no drips gave warning. The job was small and no one was at work in the engine room, all overhauling having been completed. Had the crank not been on top center, a movement might have given an indication, or, for that matter, might have resulted in casualty. Such a method of warning, though, is not unknown, but it is done with full knowledge. In the instance cited it was a matter of accident, not design, which might have resulted in serious damage.

Now, although the oversight may be rightly attributed to the engineer on anchor watch, a greater responsibility rests on the design of the valve, which was unprovided with any indication of its condition.

The second instance concerns tank valves. These as fitted were of the center-guide type, with very limited thread length. In the replacement of one of these after overhaul the cover was replaced with the spindle in open condition. The valve guide spindle failed to get into the proper opening, and, screwing the valve down, bent the pin integral with valve. As usual, the distribution box was in a dark corner of the stokehold and the engineer making the overhaul guessed by the feel of the wheel spanner that it was down. The sea suction was also improperly closed or left off its face, and in a twelve-hour passage the steamer was 2 feet or more down by the head owing to filling of No. 2 tank. The consequences, as only part of cargo was loaded, were not serious, being confined to pumping out. With a fully laden vessel and heavy weather, the result would have been to make her less seaworthy and might conceivably have led to disaster.

How many sea injection valves for circulating water have been found with stripped threads at awkward moments it would be idle to conjecture, but the number must be considerable. To dismantle such a valve outside a dry dock afloat in port is an operation not free from danger. The usual rig with double tarpaulins under ship's bottom is a risky proceeding which might result in sinking the ship.

Now, the blame for all such instances of default lies at the door of the shipbuilder and engine designer. Valves with concealed spindle threads should never, in any instance and under any consideration of cost or builder's convenience, be fitted. If the spindle thread is external, its condition and the movement of valve can be seen. There is no difficulty in the provision of such valves. Also reliable external indication of an arrow on the hand wheel and, more essentially, an external indication of the actual position of valve relative to seat should be provided. It should be possible in the dark to know by feel only exactly the position of the valve, while full open and shut positions should be so visible externally that they can be seen whenever the eye chances to fall upon them. It also costs little to place a brass plate on every valve in a ship clearing stating what it is, so that no mental work or time to trace pipe lines is needed before its use is apparent.

A distribution box is essentially a more mechanical device than a three or four way cock. The latter is certain to leak after the passing of time, and to grind in the plug of an 8-inch diameter cock costs more in time and labor than can be spared in a steamer's engine room. If the designer had to do the grinding in there would be less cocks fitted of any relative size.

If Mr. Designer will give us valves with external threads, have reliable indicators fitted, fit fewer cocks and himself see that engraved brass plates are affixed to each valve, we shall all be duly grateful. If, in addition, he will draw a large size piping diagram on the lines of an electrical plant wiring diagram and insert same permanently in a panel of the mess room with thick plate glass in front, he will be of service. If, in addition, he will so group the valves which are themselves controlling gear in positions which instinctively label themselves in place of saving a few feet of piping to assort the valves in unrelated position, his memory will be blessed.

Too little regard is paid to the question of convenience of the operation, too much to a cent-wise and dollar-foolish outlook in the matter of pipe. The question of piping and the control points—e. g., the valves—is work worthy of brains and intelligence. Some steamers' arrangements make one think this had been an oversight hastily remedied at the last moment by an incompetent junior. There is nothing more galling to the engineer afloat than the haphazard arrangements met with which could have been rectified at no increased cost when the job was in the paper stage.

A. L. HAAS.

London.

Setting and Care of Spring Loaded Safety Valves

The first law about safety valves should be that no one who does not thoroughly understand them be allowed to try setting or making any repairs to them. They are the guardian of many lives and the protector of considerable property. The inexperienced can best learn by assisting a few times some capable man to make repairs and adjustments and by procuring printed matter from the makers of the type of safety he desires to learn about.

Perhaps the most common trouble with safety valves is sticking, when either open or closed. This in almost all cases is due to lack of care. When a safety lifts by steam, if there is any scum or sediment in the water or dry pipe, there will be some of it left in the safety valve. It dries on and starts trouble unless the safety valves are lifted each day with the hand-lifting devices. When a safety sticks open, most people send a man up to tap the stem to seat it, and if it is stubborn he hits it a little harder and maybe bends the stem or upsets it. This is bad practice and it can be avoided by use of the hand-lifting device and a cleaning of valves when the boiler is under repair or cleaning. The safety valves can be removed without disturbing the setting in most types, their parts cleaned, lubricated and replaced.

The prevention of rusting and corroding of the springs is very important. The springs should be nickled, as this protects them, and each plant should have at least 10 percent of the total number of springs spare. The springs of most types of safety valves are enclosed in an atmosphere cylinder. This is intended to eliminate the escaping steam pressure, acting on top of the valve, and not as a protective compartment for the spring. Some steam vapor or moisture from the air will always find its way in to attack the springs. This compartment does, of course, reduce the chances of corrosion, in keeping the escaping wet steam from direct contact with the spring.

To maintain the working parts of a safety valve in good order I recommend the use of a good grade of graphite lubricant. The use of oil is of little value, as the heat over the boilers soon dries it, and if it is a poor grade will leave the parts gummed up. This applies especially to the parts of the hand-raising devices.

The setting or adjusting of the valves to rise at the same working pressure and reseat with a small loss is accomplished by compressing the springs with the nut sleeves and adjusting the blow back ring or lip, bearing in mind that decreasing the space between the ring and seat makes the valve rise for a longer period, and increasing the space allows it to blow for a shorter period. Five pounds is the proper amount to allow it to blow back. If the ring is moved too far away, it will allow the valve to lift and chatter until such time as the pressure falls below the setting, which it does only when you have your steam controlled. Chattering injures the valve seats and should not be allowed. The blow back rings are secured by a plug screw or other means and it should be done carefully to prevent their changing.

When setting the valves of a safety composed of two or more valves in one body the others must be gagged down. Only one valve of a set can be properly set at a time. I have known engineers that in place of gagging down the other valves would screw down hard on their adjusting nuts. This is very poor practice and I think injures the spring tension.

Always, when setting the safety valve of a boiler that is connected to a battery of boilers, use a test gage, or master gage, and do not go by the one on the boiler. It may be all right, but the test gage is the best method and insures the proper setting of all valves. The plan used for settings in this plant is that the boilers furtherest away from the main engines are set to blow 5 pounds lighter than the ones nearest to them.

When you are raising steam in a boiler, to set its safety remember to have sufficient water in it to do the work safely, for if the other boilers are carrying lower steam pressure, as, for instance, say 125 pounds, and the one you are setting has to be raised to 225 pounds, you will not be able to feed it against this pressure and you have the trouble of cutting it into the steam line in order to lower the pressure to feed it. This wastes time, and setting safety valves is a hot, uncomfortable job, so it is well to make a few preparations ahead of time.

When connecting up the hand-lifting devices after setting the valves examine them to see that all valves lift together, if there are more than one. This is accomplished by proper fitting of the keys through the stems and adjustment of any lost motion in the levers.

C. H. W.

A Poor Combination

A month ago I boarded a steamboat for a little vacation trip, and, of course, wanted to know what kind of machinery they had on the boat and how it worked.

I was directed to the chief engineer first, met him, asked if I could "look around," and was obligingly told that I could. In fact, he went so far as to instruct his assistant to show me whatever I wanted to see.

It was evident at a glance that the chief was a busy man indeed. He was poring over some blue-prints all the time that he spoke to me, and so, not wishing to be a disturber, I went my way with the assistant.

Now, the assistant was a good enough kind of a fellow, but I immediately learned that he leaned too heavily on the chief. He couldn't answer many of my simplest questions. He knew the speed of the boat, the turns per minute of the propeller, construction of parts and other things that even the oilers might know, but he knew nothing definite about the efficiency of the engines. He had helped to take cards and set valves, but he didn't know the results. "The chief knows," he would state, as though he expected me to ask the chief, and as though such ignorance was excusable.

He didn't know why the vessel as equipped with engines rather than with steam turbines. He knew how the refrigerating system worked, but didn't know if it was a compression or absorption system.

He didn't know the exact total power of the engine, but "the chief knows," he said.

The engines were very noisy—so noisy that I had to shout into his ear from a distance of about one inch. "Where is the knock?" I shouted when we were close to a particularly noisy spot. He pointed into a mass of moving cranks and rods and shouted back: "In there; low pressure valve; the chief knows!"

So I concluded that there was something wrong somewhere in the management of the engineering department. Either the chief wanted to keep his assistant in ignorance, as is often the case, or the assistant was following the wrong vocation. On the surface it looked as though the chief did all of the heavy thinking. The assistant didn't seem to care. He could have easily known most of the things he didn't know, in spite of the chief.

I have been on several steamboats in my lifetime, but I never before heard such noisy engines anywhere. It is therefore my own personal opinion that they should have a new chief and a new assistant on that boat.

New York. N. G. NEAR.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, and defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Rake of Masts

Q.—What is the customary rake to masts and stacks of steam vessels 300-500 feet in length? S. B.

A.—It varies somewhat with the characteristics of the vessel and the preference of the designer. A common rule is to slightly increase rake of each member as you work aft, starting with about ¾ inch per foot for the foremast, 1 inch per foot for the stacks, and 1¾ inch per foot for the mainmast.

Aeroplane Propellers

Q.—Why are aeroplane propellers always two-bladed? A. E.

A.—They are not. Three-bladed propellers are common, and some of the new European war machines have four-bladed propellers. In general, two-bladed propellers are more efficient, and are used. If in design the horsepower of the engine requires an abnormally large diameter for a two-bladed propeller the designer reverts to increasing the number of blades, thereby decreasing the diameter.

Heat and Mechanical Energy

Q.—Please advise through your columns whether the heat generated by compressing air is due to friction or to the concentration of the heat contained in the larger volume into the smaller volume? V.

A.—To neither; but to the *work* expended in compressing it, which is transformed into heat. Heat is not matter, but, according to accepted conceptions, a form of energy. The old "caloric" theory considered heat as an all-pervading *fluid* which actually flowed from the hotter to the colder body when the two were placed together, but this was definitely disproved by Rumford, Davy and Joule, the latter establishing the quantitative evaluation between work and heat. The present conception of heat is that it is a name given to an active agent to account for changes in temperature; that it is not a substance, but a form of energy, and that this energy is due to the motion or relative positions of the molecules of a body or system. Heat may be generated by the expenditure of mechanical energy, and, conversely, work may be produced by the expenditure of heat.

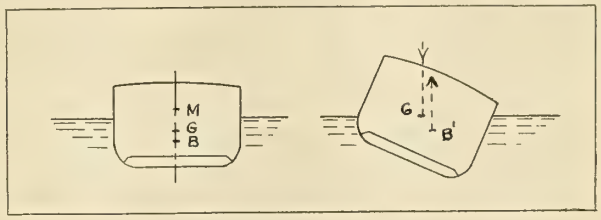
The instance you cite belongs to the former category, while in the latter is the steam engine, hot-air engine, etc.

If you strike an anvil a blow with a heavy sledge its face becomes heated, and simply because you have converted the kinetic energy (which is by definition "the ability to do work") $\frac{M v^2}{2 g}$, into heat; in the same way when you do work in compressing air the equivalent of the work done is given to the air in the form of heat with attendant rise of temperature. The quantitative evaluation of this energy transformation is given by the mechanical equivalent of heat, or 1 B.t.u. = 778 foot pounds of work, which may be stated that 1 B.t.u. requires for its production, and can produce by its disappearance, 778 foot pounds of work.

Metacentric Height

Q.—In a ship the center of buoyancy usually lies below the center of gravity. Can you explain to me why it is that still the ship has stable equilibrium? If the buoyancy acts at B and the weight acts at G, I should think there would be unstable equilibrium, like a balanced stick. E. B.

A.—As soon as a ship is heeled, the center of buoyancy moves over, as it is the center of figure of the immersed careen, and the buoyancy acts through this new position of the center of buoyancy, B^1. Taking the product of the displacement and the horizontal distance between the $C.\ G.$



Position of Center of Buoyancy

and the new position of the $C.\ B.$ gives the righting moment. The smaller the angle of heel the smaller the righting arm and the more nearly the vertical through the new $C.\ B.$ cuts the original vertical in the position B. If at the limit it actually came down to B your conception would be correct, but it can be shown that it never gets to B, but is above it even at zero inclination. This point, the intersection of the vertical through the new $C.\ B.$ with the original vertical is called the metacenter (M), and is where the buoyancy should be considered as acting for all computations.

Labor Costs

Q.—I wish to secure the following information pertaining to contract labor in shipyards: Tables showing the price of removing cast iron or steel in lathes or planers per cubic inch or per surface inch in different thicknesses, rough machined and finished. The cost of punching holes in steel plates and angles and driving rivets per hundred of different dimensions; also fitting plates per hundredweight.

There are tables of this kind in use in Europe, to the great benefit of the manufacturers and shipyards, as well as to the benefit of the employees. Of course these tables are used as a base only and the prices vary in different localities. K.

A.—Rates of prices for piece workers in the shipbuilding trade are published in Great Britain in booklet form by the various trade unions, and are issued to their members as confidential information. These itemize work and prices in great detail and serve as a basis of estimation and payment for all contract work between the piece worker and the shipbuilding company. There are no similar data issued in this country, and the foreign sheets are of very little value here, even as a base, because the method of contracting and rates of pay differ so greatly.

The most concrete information as to prices actually paid

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

Cost of Riveting (Machine Work).
RIVETING MACHINE.
PART I

CLASS No.	Class of Work determined by conditions: (a) Accessibility for riveting. (b) Complexity and difficulty determine skill required. (c) Continuity or contiguity of rivets.	Price Per 100, dollars and cents. Diameter of Rivet.						
		⅜	½	⅝	¾	⅞	1	1⅛
	S—Size Number.	3	4	5	6	7	8	9
0	On Ground-Riveting with Bull Machine	....	1.00	1.25	1.50	1.75	....	7.50
1	On Ground-Easy structural work with air hammer	1.00	1.25	1.50	1.75	2.00	....	....
2	On Ground-Bulkheads, Decks, Floors	1.25	1.50	1.75	2.00	2.25	....	....
3	On Ship-Beam brackets and gussets, Bulkheads, Deck, Deck houses, Floors, Longitudinals	1.50	1.75	2.00	2.25	2.50	2.90	....
4	Keel-Keelson, Inner bottom, Shell-Hatches and Coamings, Bounding-bars, Stringers, Turrets	1.75	2.00	2.25	2.50	2.80	3.20	....
5	Boat cranes, Chutes, Trunks, Doors, Manhole Covers, Guards, Masts, Bulkhead Staples, Clips	2.00	2.25	2.50	2.75	3.10	3.60	....
6	Ammunition hoists, Bilge Keels, Cofferdam, Chain Lockers, Peak Tanks	2.25	2.50	2.75	3.00	3.50	4.10	....
7	Boiler Saddles, Engine Foundations	....	2.75	3.00	3.40	3.90	4.60	....
8	Stanchions, Miscellaneous Foundations, Struts, Rudders	....	3.00	3.30	3.80	4.40	5.20	....
9	Stem, Sternpost	....	3.25	3.70	4.30	5.00	6.00	7.50

CLASSES 3 and 4 are Flush riveting prices, in new work. Deduct 0.25 per 100 for snap riveting prices in new work.

in an American yard is given in "Estimating the Cost of Work," by W. B. Ferguson, which gives actual costs of work.

From this the cost of punching material delivered to the machine is:

	Per 100 Holes
(1) Small plates or shapes handled by two men	$0.10
(2) Large plates or shapes handled by two men, ½ inch and under	0.20
(3) Large plates or shapes handled by four men, over ½ inch	0.25

Effect on Ship of Unbalanced Forces in Twin Screw Engines

Q.—A vessel is provided wtth two sets of engines driving twin screws which are at a distance of 14 feet apart. Each crank shaft has two cranks at right angles to each other. The weight of the reciprocating parts of each engine is 3 tons; the stroke, 39 inches; the revolutions, 140 per minute. Determine the greatest force tending to uplift or depress the vessel; also the greatest heeling moment. VANDUARA.

A.—The greatest vertical free-force occurs when a crank is at the top or bottom of its stroke, then the accelerating force along the line of dead points is a maximum.

The accelerating force can be expressed as follows:

$$\text{Accelerated force} = \text{factor} \times \text{R. P. M.}^2 \times r \times M,$$

where r = radius of crank in feet,
M = mass of reciprocating parts.

The factor is dependent upon ratio of connecting rod length to crank length and angle of rotation, and is simply the reduction of the rather involved analytical expression. This has been published in "Dynamics of Machinery," by G. Lanza (p. 53), from which the following values are taken:

Crank Angles.	Ratio of Connecting-rod to Crank 4½:1.	Crank Angles.	Ratio of Connecting-rod to Crank of 4½:1
0:360	0.01340	120:240	0.00670
30:330	0.01075	150-210	0.00825
60:300	0.00427	180:180	0.00853
90:270	0.00250		

Considering the reciprocating parts for each cylinder as weighing 1½ tons, or 3,360 pounds, then the accelerating force at the top dead center is

$$(0.01340 - 0.00250) \times 140^2 \times \frac{39}{12 \times 2} \times \frac{3{,}360}{32.2} = 36{,}200 \text{ lbs.}$$

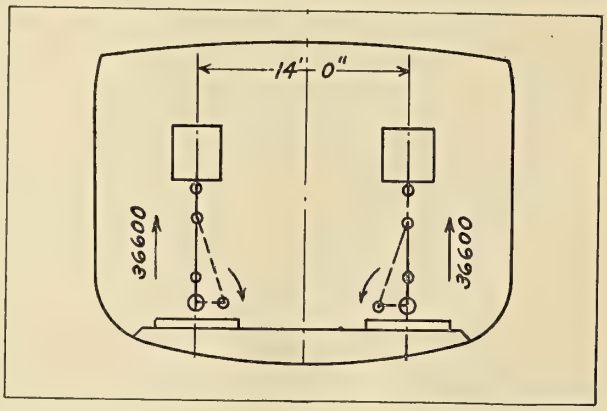
Similarly for the bottom center the accelerating force is

$$(0.00853 + 0.00250) \times 140^2 \times \frac{39}{12 \times 2} \times \frac{3{,}360}{32.2} = 36{,}600 \text{ lbs.}$$

These include the accelerating force along the line of dead points of the cylinder, whose crank is at 90 degrees from the one at dead point.

If the two engines get in step the total lifting force will be $2 \times 36{,}200 = 72{,}400$ pounds, and the depressing force will be $2 \times 36{,}600 = 73{,}200$ pounds.

If the engines were in step, but with one just at the top dead center when the other was at the bottom dead center,



Action of Vertical Free Force

there would be a heeling moment of $73{,}000 \times 14 = 1{,}022{,}000$ foot pounds.

Attention should be called to the fact that while the above gives a correct estimation of the magnitude of these forces in their actual operation, they are of but extremely brief duration and reverse their direction twice each revolution, so that their effect cannot be compared to the effect produced by a steady force of the same magnitude.

Books on Marine Engine Design

Q.—I am writing to see if you can help me on some work I am doing. I am a student at ———— and am specializing in marine work. I have a triple expansion marine engine of 2,500 horsepower to design, and up to date I have been unable to get hold of any design in any way similar to the one I am making. I wonder if you can send me any specifications and blueprints which would be of any service to me, or if this is not possible, tell me where I could get hold of such a design. Also can you tell me of any other good book beside Seaton's Manual which I could use. R. L.

A.—"Computations for Marine Engines," by C. H. Peabody, published by John Wiley & Sons, will give you just the information asked for. This takes up the complete design of a triple-expansion marine engine of 2,500 indicated horsepower of the standard merchant type. Seaton & Rounthwaite's "Pocket-book of Marine Engineering Rules and Tables," new (12th) edition, is a better book than Seaton's Manual for your needs.

Shipbuilding and General Marine News

Contracts for New Ships—Marine Terminal Improvements—Recent Launchings—Improved Appliances—Personal Items

The sale of the fifteen million dollar plant of the New York Shipbuilding Company, Camden, N. J., to the American International Corporation, the International Mercantile Marine Company, W. R. Grace & Company and the Pacific Mail Steamship Company was ratified at a special meeting of the stockholders of the New York Shipbuilding Company on November 27. The present officers of the company will not be changed. The company now has contracts which will fill the present capacity of the yard through 1917, but improvements and extensions are planned which will materially increase the capacity of the yard. Government work will be undertaken by the company, if offered, although the demands for the renewals of the fleets of the new owners, together with private business now on hand and in contemplation, it is expected will use the entire capacity of the yard and its extensions for the next five years.

The International Mercantile Marine now has fourteen ships under construction aggregating over a quarter of a million gross tons and is planning for the construction of four turbine passenger ships of about 32,000 gross tons each and of 25 knots speed for the American Line. It is expected that the Pacific Mail Steamship Company will soon place contracts for several large vessels and the Grace Company is also in the market for new tonnage.

Tentative negotiations are also understood to be under way for the merger of the Newport News Shipbuilding and Dry Dock Company, Newport News, Va., and the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa. Although two large steel companies have been mentioned in connection with these negotiations, this rumor has been denied.

Ten Months of American Shipbuilding

The Bureau of Navigation, Department of Commerce, reports 968 sailing, steam, gas and unrigged vessels of 405,894 gross tons built in the United States and officially numbered during the ten months of the calendar year 1916. Of these, 76, aggregating 274,843 tons, were steel steamships. In addition to the above there were built for foreigners 36 wooden vessels of 372 gross tons and 11 steel vessels of 25,418 tons.

During the month of October 108 vessels of 54,029 gross tons were built, 12 of which were steel steamships, aggregating 31,785 gross tons.

Progress of American Shipbuilding

Steel merchant vessels building or under contract to be built in private American shipyards on November 1, 1916, according to builders' returns to the Bureau of Navigation, Department of Commerce, number 417, of 1,479,946 gross tons, an increase of 25,676 tons over the returns for October 1. During October American yards finished 17 steel merchant vessels of 52,491 gross tons, and made new contracts for 17 steel merchant vessels of 77,877 gross tons.

Shipbuilders in the United States expect to launch 314 vessels of 960,899 gross tons during the current fiscal year, and 103 vessels of 519,947 gross tons during the fiscal year ending June 30, 1918.

To build the naval vessels authorized in this year's naval programme, bids for which are now being considered by the Navy Department, a total of about 167,000 tons of steel will be required.

Marine engine and repair plants in the Pacific Northwest are experiencing a remarkably prosperous season, some of the larger plants are running both day and night shifts.

Fifty-three wooden vessels designed for the lumber traffic are now in course of construction in Oregon, Washington and British Columbia. In the construction of these vessels approximately 106,000,000 feet of lumber will be used, and when completed the vessels will have a combined lumber-carrying capacity of 79,500,000 feet.

Shipbuilding Notes

The building programme of the Bethlehem Steel Company, South Bethlehem, Pa., for vessels for its own use in bringing iron ore from Chile, Cuba and other countries, calls for the construction of twenty-five steamships of about 17,000 gross tons each. The company already has five steamships under construction at the Maryland Steel plant and more keels will be laid as launching ways can be spared.

The Ocean Steamship Company, known as the Savannah Line, W. H. Pleasants, president, Pier 35, North River, New York, is in the market for several more vessels. This company is already building two splendid passenger ships at the Harlan & Hollingsworth yard, Wilmington, Del.

An official of the Atlantic Gulf & West Indies Steamship Company, H. H. Raymond, general manager, Pier 30, North River, New York, is reported by the best of authority to have stated that his company is in the market for a large number of vessels, aggregating about fifty, if prices and time of delivery can be agreed upon.

The American Shipbuilding Company, Warrenton, Ore., Harry B. Spear, president, has received contracts to build six wooden motor ships, each to have a capacity of 2,000,000 feet of lumber.

The Anderson Steamboat Company, Seattle, Wash., has received a contract to build two 8,800-ton ships for Hannevig & Johnsen, New York.

The Wallace Shipyards, North Vancouver, B. C., have received contracts to build two steel steamships.

John Coughland & Sons, Vancouver, B. C., have a contract to build one steel steamship.

The Seattle Construction & Dry Dock Company, Seattle, Wash., has given a contract to the McAteer Shipbuilding Company, Seattle, Wash., to build the first four sections of its 20,000-ton floating drydock.

The Seaborn Shipyards, Tacoma, Wash., are reported to have contracts on hand to construct wooden vessels to cost more than $1,000,000.

The Grays Harbor Shipyards, Aberdeen, Wash., have received contracts to build six lumber schooners to be equipped with Diesel engines.

The Seattle Construction & Dry Dock Company, Seattle, Wash., has recently received a contract for an 8,000-ton steel freighter for Barber & Company, New York.

Shipyard Notes

The Texas Company, 17 Battery Place, New York, is planning to build a dry dock and machine shop at Bath, Me.

J. F. Duthie & Son, Seattle, Wash., will greatly enlarge their shipbuilding plant at Seattle.

The Newburgh Shipbuilding Company, Newburg, N. Y., F. N. Bain, president, has awarded a contract for several buildings.

The Government of the Republic of Chile, South America, will build a very complete navy yard. Commander Julio Dittborn, naval attache, Chilean Embassy, Washington, D. C., has requested MARINE ENGINEERING to send this information to all concerns interested in furnishing navy yard supplies and equipment. All letters must be very complete, giving full information regarding equipment, together with prices, time of delivery, etc.

The Shipbuilding Joint Stock Company, "Noblessner," of Petrograd, Russia, asks MARINE ENGINEERING to request firms engaged in the manufacture of articles of ship equipment or goods and machinery relating to the shipbuilding business to send their catalogues or publications in duplicate, stating the name and address of their representative in Russia or elsewhere to whom inquiries should be addressed. Communications should be addressed to Shipbuilding Joint Stock Com-

pany, "Noblessner," Petrograd (Russia), Sampsonievsky quay 3.

It is reported that William Cornfoot, of the Albina Machine Works, Portland, Ore., will build a shipyard in connection with his plant, and that he has secured contracts to build two 3,300-ton steel steamships.

The Oregon Shipbuilding Company, Portland, Ore., has been incorporated by Carlton E. Spencer, George E. Hobson and C. A. Sheppherd. The new company has already received contracts to build four 8,800-ton steel freight ships for Norwegian interests.

Work has been begun on the shipbuilding yards of the Anderson-Seilzik Shipbuilding Company, Seattle, Wash., and the company is stated to have received contracts to build two 9,000-ton freight steamships for Norwegian interests.

The Pusey & Jones Company, Wilmington, Del., is placing large orders for equipment for new shops which it has erected.

The Buffalo Dry Dock Company will build a two-story reinforced concrete warehouse and shop at its plant in Buffalo.

A shipyard is being constructed at Tsurumi, on Tokyo Bay, north of Yokohama, Japan, for the president of one of the large Japanese steamship companies. The area of the yard will be about 115 acres, and four shipways will be provided for building ships of 10,000 tons.

The Seattle Construction & Dry Dock Company, Seattle, Wash., is about to distribute 300 shares of its stock, now earning 7 percent, among its yard employees, and, in addition, will distribute 450 and 500 shares among its executive staff and office force.

The Bethlehem Steel Company has awarded contracts for a large number of cranes required at its Maryland Steel Company plant, Sparrows Point, Md. The Morgan Engineering Company and the Alliance Machine Company, both of Alliance, Ohio, were the successful bidders.

On October 20 announcement was made of the taking over by the State of Massachusetts of land on both sides of Hayward's Creek at Quincy, Mass., 150 acres of which will be developed by the Commonwealth for steamship and railroad terminals. A portion of this land not required by the Commonwealth for this development will be leased for a long term of years to the Fore River Shipbuilding Corporation, which intends to erect building slips, shops, etc., for accommodating new work. These additional building facilities will allow for an extensive expansion of the Fore River yard.

The Albina Engine & Machine Works, Portland, Ore., is negotiating for several contracts for steel steamers of 8,000 tons or more capacity, and is planning to enlarge its yard to meet the demands for new construction.

A controlling interest in the McEachern-Standifer-Clarkson Ship Company, of Astoria, Ore., has been purchased by A. O. Anderson & Company, Ltd., of Copenhagen, incorporated in the States of Oregon and New York. Guy M. Standifer and James Clarkson, Astoria, will retire from the company and devote their interests to the Standifer-Clarkson shipyard on North Portland harbor. The McEachern yard, situated on Young's Bay, is now building several auxiliary schooners of the five-masted type.

Recent Launchings

The Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md., launched on October 28 the oil tanker *Homer Evans*, 306 feet long by 47 feet beam by 28 feet depth, of 3,500 gross tons, for Hannevig & Johnsen, New York.

The Seattle Construction & Dry Dock Company, Seattle, Wash., launched on October 21 the 6,000-ton steel freighter *Panuco* for the *Ward Line*.

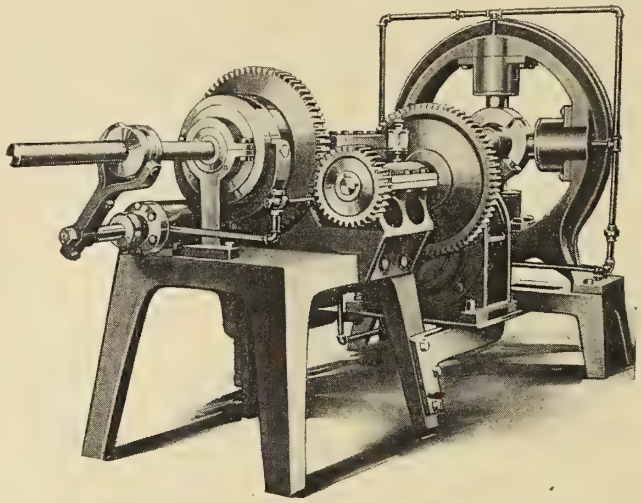
The Union Iron Works, San Francisco, Cal., launched on October 24 the tank steamer *H. C. Folger* for the Atlantic Refining Company.

The New York Shipbuilding Company, Camden, N. J., recently launched the tank steamer *Royal Arrow*, 475 feet long, 62.3 feet beam and 39.6 feet depth, for the Standard Transportation Company, New York. The *Royal Arrow* has a carrying capacity of 4,000,000 gallons. Propulsion is by triple-expansion engines, supplied by Scotch boilers designed to give the vessel a speed of 10½ or 11 knots.

A comprehensive project for the remodeling of all the leading navy yards in the United States and the creation of two completely equipped naval bases, involving an expenditure of from $50,000,000 (£10,250,000) to $100,000,000 (£20,500,000), has been laid before Congress in formal recommendations submitted to the House Committee on Naval Affairs by Rear-Admiral Harris, Chief of the Bureau of Yards and Docks.

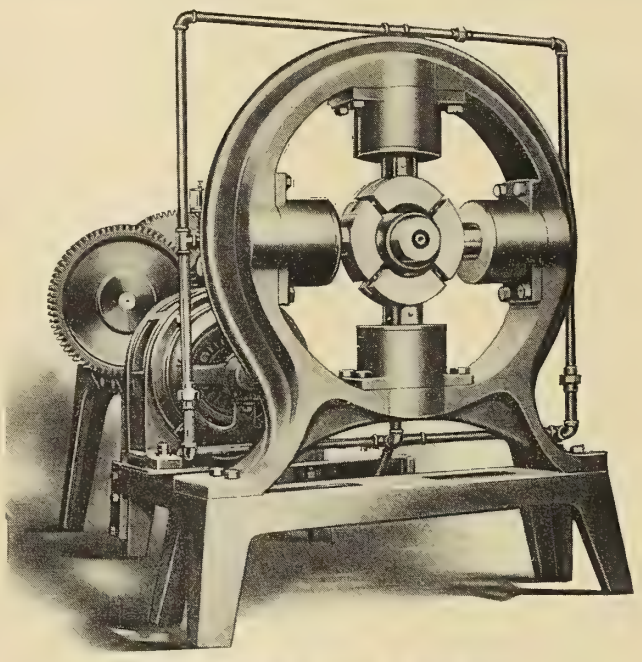
Universal Flue Welder

The Southwark universal flue welder, manufactured by the Southwark Foundry & Machine Company, Philadelphia, Pa., is built sufficiently heavy to perform the welding of the large flues, and takes safe ends of lengths greater than the limits of the ordinary types of welder. A special device allows the working of the weld on the inside instead of on the outside



Driving Mechanism at Back of Universal Flue Welder

of the tube. The clamping head at the front and the driving mechanism at the back are the two main parts of the machine. The clamping head is made from one circular-shape casting, four air cylinders being mounted on the inside. The pistons are fitted with metal snap rings, instead of the ordinary cup leather type. The front end of the piston rods are equipped



Clamping Head at Front of Flue Welder

with sectional dies. These clamp the outside of the flue at the line of weld.

Piped up to a single air line the cylinders operate simultaneously with the opening of the valve. Running through the center of this head longitudinally with the machine is the welding mandrel which fits the inside of the flue.

Four rollers are assembled in the body of this mandrel, which is hollow. Tapered and free in their bearings, they can be moved radially by inserting a taper mandrel that reaches through the middle of the spindle from the back of the machine. This mandrel is operated by an air cylinder, also controlled by the main foot valve. The main mandrel is driven through two gear reductions to a 1½-horsepower motor.

An adjustable platform in front of the welder head, which supports the welding furnace, permits the proper location for different lengths of safe ends.

A cast iron tank or water back protects the welding head from excessive heat from the furnace. The size of the mandrel, back of the welding rollers, approximates the inside diameter of the flue. This supports the weight of the safe end while being heated and moved to the welding position, which prevents any loss due to the dropping off of safe ends, as frequently occurs.

Naval Architecture to be Taught at George Washington University

A course of instruction in naval architecture, covering a period of one year, has been established at the George Washington University, Washington, D. C. Rear-Admiral Charles H. Stockton, president of the University, and Dean Howard L. Hodgkin, of the College of Engineering, are considering the advisability of introducing a complete four-year course in marine engineering and naval architecture. The proximity of the George Washington University to numerous large shipbuilding plants, the naval model basin and the offices of the Navy Department, it is believed, render it ideally situated for such work. The fact that studies may be taken evenings permits enrollment of students otherwise employed during the day. Arthur F. Johnson, M. E., is instructor in charge of the work in naval architecture.

Motor Tank Ship Bramell Point Sails on Her Maiden Voyage

The motor-driven oil tanker *Bramell Point*, the first American commercial motor-driven ship ever built, arrived in New York harbor on November 9 from Baltimore, Md., after a satisfactory trial trip. The *Bramell Point* is owned by the Vacuum Oil Company, of 61 Broadway, New York.

The vessel was launched at Baltimore July 1. She has a capacity of 5,000 tons, is 293 feet long, 47 feet beam and has a depth of 28 feet. Her three Bolinder oil engines develop 1,650 horsepower.

She flies the American flag, is manned by a crew of 28 American seamen, and is in command of Capt. Andrew Munkowitz.

After loading a cargo of refined oil at Bayonne the *Bramell Point* sailed for Lisbon, Portugal, on her maiden trip. It is expected that the round-trip will consume about 30 days' time. On her return to New York she will be continued in overseas trade.

Puget Sound Branch of American Society of Marine Draftsmen Holds Its First Annual Banquet

On Saturday evening, October 14, fifty-three members and guests of the Puget Sound Branch of the American Society of Marine Draftsmen, gathered together at the Hotel Butler in Seattle, Wash., for the first annual banquet of this branch of the society. Before the banquet the members met in one of the spacious meeting rooms of the hotel and the business of the society was discussed.

The toastmaster for the evening was Mr. A. F. Reeves, who spoke, in part, of the obect of the society, and of the urgent need for maintaining a high standard of efficiency among the members, so that the name of the society would not only act as a title, but carry with it a high standard of proficiency which would be looked upon with esteem by all.

Mr. D. G. Smith, president of this branch, pointed to the fact that heretofore when ships were built to fill the demand and against keen competition, and positions were not easily obtained, the draftsmen worked as individuals, but now that shipbuilding has become an enterprise involving great prosperity, the draftsmen should work in the strength and unity which the present time affords, and to be willing to offer their brains and skill to the country when necessity arises.

Reference was made by Mr. E. F. Maas to the proposed joint study classes and lectures, and to the club house and reference library to be established for the benefit of the members.

Other speakers of the evening were Mr. R. M. Semmes, president of the Alaska Pacific Navigation Company, who expressed his belief that shipbuilding will steadily progress in this country after the war; and Mr. J. H. Todd and W. C. Nickum, both of the Seattle Construction & Dry Dock Company, pledged their support to the organization, and pointed to facts to show the importance of draftsmen to the shipyard arganization and the responsibilities which they assume.

PERSONAL

ROBERT C. MILLER has been appointed purchasing agent of the Staten Island Shipbuilding Company, New York, succeeding W. H. Moore, retired.

JAMES DONALD, a well-known marine engineer and naval architect, formerly practising in London, has been appointed general manager of the States Marine & Commercial Company, Inc., ship and insurance brokers, steamship forwarding and general agents, with offices at 17 Battery Place, New York.

EDMUND VICTOR TELFER, an apprentice in the service of Messrs. William Gray & Company, Ltd., West Hartlepool, has been awarded the 1916 scholarship of the North East Coast Institution of Engineers and Shipbuilders, Newcastle-upon-Tyne.

H. F. ALEXANDER, of Tacoma, Wash., who twenty-two years ago was a 'longshoreman on the Tacoma docks, is now at the age of 37, head of the Pacific Steamship Company, the largest coastwise steamship company on the Pacific.

CHARLES H. POTTER, formerly general manager of the Luckenbach Steamship Company, New York, is president of the Potter Transportation Company, Inc., and vice-president of C. W. Chadwick & Company, both of New York.

PAUL H. COOP, who is well-known in engineering circles on the Pacific Coast, has been appointed representative of the Eckliff Automatic Boiler Circulator Company, with offices in the Hobart building, San Francisco, Cal.

OBITUARY

CHARLES BOOTH, chairman of the Booth Steamship Company, died on November 23 in London, aged 56.

THOMAS BARNETT MILLER, for many years a member of the shipbuilding and ship repair firm of Alexander Miller & Bros., Jersey City, N. J., died on November 8 in Brooklyn, N. Y., aged 52 years.

JAMES C. WALLACE, president of the American Shipbuilding Company from 1905 to 1914, died at his home in Cleveland, Ohio, on October 31, aged 52. Since retiring from the shipbuilding firm Mr. Wallace has devoted himself to vessel interests on the Great Lakes.

WILLIAM J. BURLEE, president of the Staten Island Shipbuilding Company, West New Brighton, N. Y., died on November 7 at his home in Port Richmond, N. Y., aged 55. Mr. Burlee organized the Staten Island Shipbuilding Company in 1898, and was president of it up to the time of his death.

CAPTAIN HOWARD PATTERSON, instructor, lecturer and author on nautical astronomy and theoretical navigation, and founder of the New York Navigation School, died on September 1 at his home in Brooklyn, N. Y., aged 61. Captain Patterson acted as private tutor on nautical subjects to many prominent yachtsmen in the United States.

CAPTAIN JAMES MCALLISTER, founder of the old Greenpoint Lighterage Company, which has since been merged into the firm of McAllister Bros., and controls more than 100 boats in the lighterage business of New York harbor, died recently at his home in Brooklyn. At the time of his death Mr. McAllister was general manager of McAllister Bros., and also president and general manager of the McAllister Dry Dock & Shipyard Company, Port Richmond, Staten Island.

EDWARD THOMAS HENDEE, secretary of Joseph T. Ryerson & Son, Chicago, died in Minneapolis, Minn., on November 12, aged 36. Mr. Hendee became associated with Joseph T. Ryerson & Son in 1902 as advertising manager, later becoming manager of the machinery department. In 1911 he was made assistant to the president, and in 1913 assumed charge of the railway supply department, while later in the year he was elected secretary of the company.

CORRECTION.—The statement on page 485 of our November issue, to the effect that the new plate and angle shop at the Fore River Shipyard is said to be the largest shop of its kind in the world appears to be erroneous, as the floor area of this shop is approximately 144,450 square feet, as against a floor area of 152,860 square feet for the plate and angle shop of the New York Shipbuilding Company, Camden, N. J.

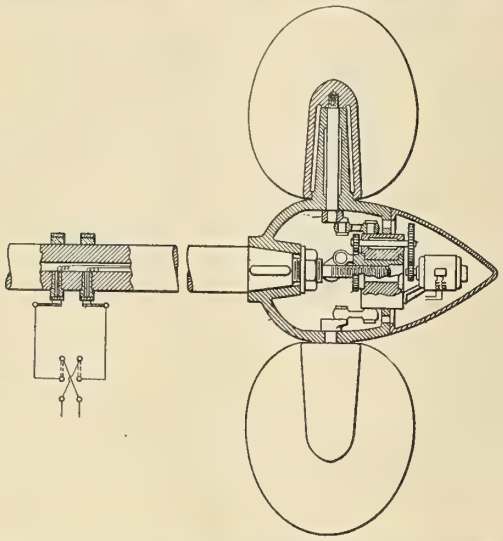
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,181,458. REVERSIBLE SCREW PROPELLER. ANATOL DAVID ISKOLS, OF SCHENECTADY, N. Y.

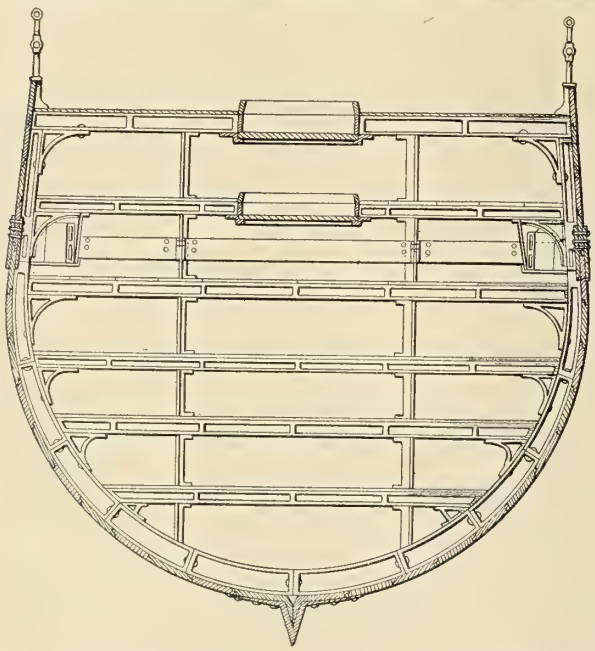
Claim 1.—In a reversible screw propeller, the combination of a hub having stands projecting outwardly therefrom to substantially the center of hydraulic pressure region of the blades, blades mounted thereon



and arranged to be angularly adjusted, each blade being supported on a stand at substantially its center of hydraulic pressure region, spindles that are supported by the stands, each of which is attached to a blade, and means located within the hub for turning the spindles and blades.

1,184,564. SECTIONAL HULL FOR SHIPS. JESSE E. OGDEN, OF EAST AUBURN, CAL.

Claim 1.—A hull for vessels, including a lower hull section having ribs, an upper hull section having ribs, the ribs of one section engaging



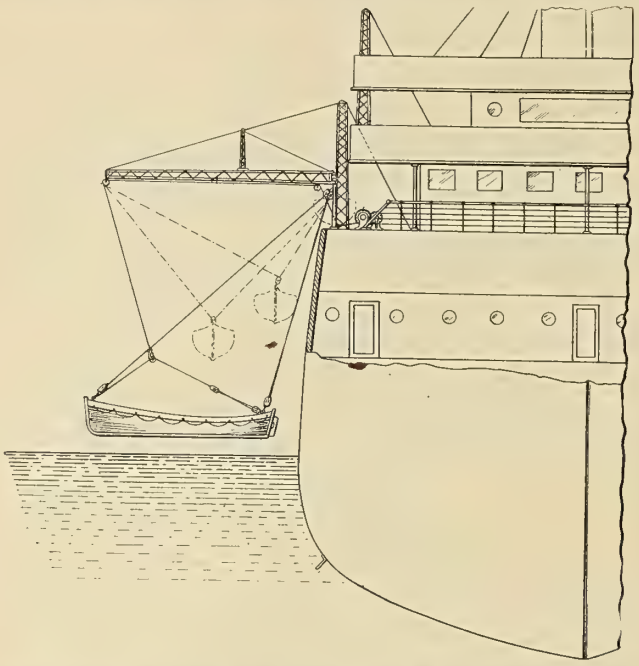
at their ends with the corresponding ribs of the other section, the ends of the ribs of one section being slotted to receive reduced ends of the ribs of the other section and the interlocking portions of the ribs being further slotted, and wedges driven through the slots of the rib sections to connect the ribs. Six claims.

1,197,666. ELASTIC FLUID TURBINE. RICHARD H. RICE, OF LYNN, MASS., ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

Claim 3.—The combination with an elastic fluid turbine, of a source of superheated elastic fluid, a conduit for conveying elastic fluid from it to the turbine, a regulating valve in such conduit, a source of elastic fluid of a lower temperature, a second conduit for conveying elastic fluid from it to the first named conduit, said second conduit connecting with the first named conduit in advance of the regulating valve, a valve in the second conduit, a thermostat which is subjected to the temperature of the exhaust from the turbine, and means controlled by the thermostat for positioning the valve in the second conduit. Five claims.

1,152,678. LAUNCHING APPARATUS FOR BOATS. SIGFRID NELSON WESSBERG, OF BROOKLYN, N. Y.

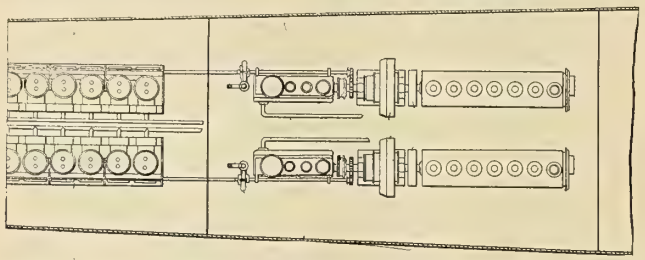
Claim 1.—A launching apparatus comprising a derrick located between tiers of boats on the deck of a ship and having a swinging boom adapted to extend beyond the ship's side more than the length of the boat to be launched, a lowering tackle on said boom, davits for supporting the boats, davit blocks and tackle connected with said davits and adapted to be connected with the boat, a boat hung on said davit blocks, a detachable span connected to each end of said boat and provided with



means midway its length for connection with the lowering tackle on the boom, one end of said span including a block and tackle whereby said end may be lengthened while the boat is being lowered. Five claims.

1,200,997. PROPELLING APPARATUS FOR VESSELS. LAWRENCE YORK SPEAR, OF GROTON, CONN., ASSIGNOR TO ELECTRIC BOAT COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

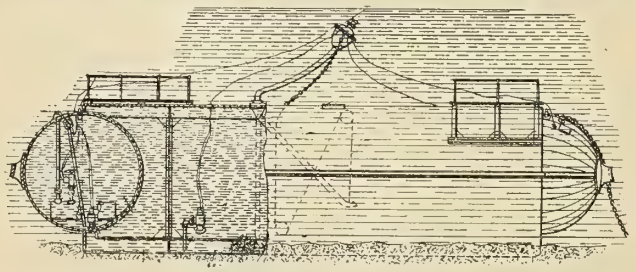
Claim 1.—In a vessel, propelling apparatus comprising the combination of a propeller shaft, a main engine, means for connecting the engine to and disconnecting it from the shaft, a dynamo-electric machine



adapted to drive the shaft, a second engine, a dynamo-electric machine driven by the last named dynamo-electric machine when the latter is operating as a motor, and electric connections between the two machines for operating either as a generator and the other as a motor. Six claims.

1,201,051. SUBMERSIBLE STORAGE TANK. CHARLES PETER MITCHELL JACK, OF BROOKLYN, N. Y.

Claim 1.—An elongated cylindrical balanced pressure tank for the storage of oil, adapted to be floated or submerged at will, in combina-



tion with valve and pipe connections for receiving and discharging oil, a delivery pipe connected thereto, and a buoy for supporting the delivery pipe to the valve-controlling device. Six claims.

1,201,737. RELEASING DEVICE. CHARLES HUNT, OF NEW YORK, N. Y.

Claim 1.—A releasing device for launching mechanism, comprising a holding bar, a locking lever co-operating with the holding bar to hold the launching tackle, a latch for supporting the locking lever, a supporting lever for the latch, a tripping dog for actuating the supporting lever, and means for actuating the tripping dog. Five claims.

TRADE PUBLICATIONS

"Flowkote" enamel, which is claimed to be especially valuable for use on board ship, is the subject of a circular issued by Harrison Bros. & Company, Philadelphia, Pa. "Supreme refinement and excellence of finish is obtained with this new white enamel—'Flowkote.' The unusual qualities of 'Flowkote' have placed it in the foreground for flowing qualities and great durability. Equally high-class effects secured on outdoor or indoor work; never checks or cracks. Not to be confused with the so-called quick-drying enamels."

Compasses and other nautical instruments are the subject of a catalogue issued by the Marine Compass Company, Bryantville, Mass. One of the instruments described and illustrated in this catalogue is the Cole course protractor, which is stated to be in use on many large vessels and to be highly endorsed by experienced navigators. The catalogue gives the following description of this instrument: "An unlimited number of courses may be taken without resetting the instrument. Variation and deviation are applied automatically. Allowances for drift and current may be made. No sliding is necessary as with the ordinary parallel rulers, and it will work equally well on a damp or wet chart. It will be found especially valuable in working a vessel in strange waters, entering harbors, or working up a coast where many courses and bearings are necessary to be taken at interrupted intervals. It enables the navigator to recognize or identify new landmarks, and in windward work enables a vessel to beat through, with confidence, passages that are otherwise difficult to navigate. The instrument is simple to operate. The rule is first placed on the compass rose or meridian lines on the chart, in some easily recognized direction, such as east and west; the dial is then turned by the thumb nut so that the reading directly under the two small pointers is also east and west. The dial is to be kept in position by keeping the fingers pressed on the thumb nut. Any movement of, or the direction of any position of the rule is automatically shown by the two small pointers. Further directions on how to use the protractor is sent with each instrument. The instrument is made of polished brass, finely lacquered. The dial base is made of heavy gage brass, and has a circle of rubber on the under side to prevent slipping. The instrument is furnished with a felt-lined mahogany case, and when cover is closed it is securely fastened in place."

"Electrify Every Ship on Your Line" is the advice given in a bulletin published by the General Electric Company, Schenectady, N. Y. "You will be surprised how much real protection and benefit electricity is on shipboard. Passengers and crew appreciate the good, bright light, and the electric fans and electric heaters are a distinct advertisement for your boats. G-E electric equipment on board ship will give the same continuous satisfactory service as the G-E generator in the big power plants ashore—they are built with the same knowledge, experience and reputation behind them."

Hoists for use on docks and piers and in shipyards are described in a circular which has just been published by the Shepard Electric Crane & Hoist Company, Montour Falls, N. Y. "We manufacture standard overhead electric traveling cranes, grab-bucket overhead electric traveling cranes, transfer overhead electric traveling cranes, jib and bracket cranes, portable electric hoists, standard cage operated monorail hoists, back-geared electric motors, T-bar current conductors, I-beam switches, trolleys, 'Shepard' double monorail track. We build these machines in a large variety of types and sizes, which constitute a complete line of hoisting equipment, in capacities of 500 pounds to 60,000 pounds."

The Southwark Gross Press for reclaiming scrap material and repairing steel cars, is described in a circular just issued by the Southwark Foundry & Machine Company, 400 Washington avenue, Philadelphia, Pa. "The rapid and almost universal adoption of all-steel equipment in railroad rolling stock created the need for a powerful press to be used in reclaiming from the scrap heap bent and damaged parts of wrecked cars, and in promoting the various other functions of the repair shop for which the older press equipment adapted to the needs of wooden cars proved inadequate. The development of the Southwark Gross Press is therefore an important step toward the solution of many railroad shop problems, and it has become a valuable and very necessary part of repair shop equipment. Its usefulness, however, is by no means confined to the railroad, as the demand for presses of increased capacity up to the standard of the Southwark Gross Press has been growing steadily in every branch of the iron and steel industries. The field for this press is almost universal, and some idea of its adaptability to the needs of general manufacturing and repair shop work may be had from a study of the accompanying illustrations and descriptive matter."

HIGHER SUPERHEAT MEANS GREATER ECONOMY

As the degree of **superheat increases** the rate of **coal saving increases.**

Condensation appears in the cylinders when **superheat disappears.**

For the most economical operation superheat is therefore essential in every cylinder, and can only be obtained by high initial steam temperatures.

The accompanying table which was presented by Mr. Harry Gray before the Institution of Naval Architects shows that 180° of superheat is not enough to provide superheated steam in the low pressure cylinder of a triple expansion engine; the same condition applies when made for a quadruple expansion engine and here 211° of superheat is not enough.

	S.S. "PORT AUGUSTA." Triple-Expansion Engines.				S.S. "PORT LINCOLN" AND "PORT MACQUARIE" Quadruple-Expansion Engines.			
STEAM CHEST.	Gauge pressure in steam chests.	Temp. due to steam pressure.	Temp. recorded.	Degree of superheat.	Gauge pressure in steam chests.	Temp. due to steam pressure.	Temp. recorded.	Degree of superheat.
	lbs.	Deg. F.	Deg. F.	Deg. F.	lbs.	Deg. F.	Deg. F.	Deg. F.
High Pressure	160	370	550	180	206	389	600	+211
1st Intermediate	53	300	400	100	97	335	460	+125
2d Intermediate	—	—	—	—	38	284	290	+ 6
Low Pressure	10	240	?	?	9	237	220	

Our fire tube superheaters are capable of furnishing an initial superheat high enough to permit the completion of the expansion in all cylinders without condensation.

Our latest bulletin shows how the savings of 12 to 20% in fuel may be made available for your ships.

Where shall we mail your copy?

LOCOMOTIVE SUPERHEATER COMPANY

New York MARINE SUPERHEATERS Chicago

Smooth-On Instruction Book No. 16, published by the Smooth-On Manufacturing Company, Jersey City, N. J., contains much information every mechanic should know. A copy will be sent free to any of our readers upon request. This book describes and illustrates actual repairs of steam and water leaks in castings, pipings, boilers, etc., that saved thousands of dollars and many hours of time.

"Advice and Comments on Many Problems and Information About Brushes" is the title of a profusely illustrated booklet of 88 pages, which has just been issued by the John L. Whiting-J. J. Adams Company, 690 Harrison avenue, Boston, Mass. The Whiting-Adams Company makes a large variety of brushes which are especially adapted to marine use—both on board ship and for use in painting docks, wharves and warehouses. A copy of this book will be sent to any of our readers, free upon request.

The Marten-Freeman compensating davit is described in an illustrated folder published by the Steward Davit & Equipment Corporation, 17 Battery Place, New York. "The Marten-Freeman compensating davit complies in every way with the requirements of the Seaman's Act, and is one of the few types that is passed without question by inspectors of the United States Steamboat Inspection Service. It will put a lifeboat from inboard to outboard position, ready for lowering, in 30 seconds, under most unfavorable conditions of list and sea. The leading American shipbuilding companies are installing Marten-Freeman compensating davits, among them being Fore River Ship Building Corporation, Maryland Steel Company, Newport News Ship Building & Dry Dock Company, William Cramp & Sons Ship & Engine Building Company. Many of the steamship lines have installed Marten-Freeman davits on existing and on new ships, among them being the Southern Pacific Company, Munson Line, Eastern Steamship Corporation, Peninsula & Occidental Steamship Company, Lukenback Steamship Company, American Hawaiian Steamship Company, Cuba Distilling Company, Texas Company, New York & South America Line. These installations are being made on freight and passenger ships. Marine engineers, naval architects and all those familiar with requirements of a davit comment favorably upon and approve of the mechanical construction and efficiency of the Marten-Freeman davit."

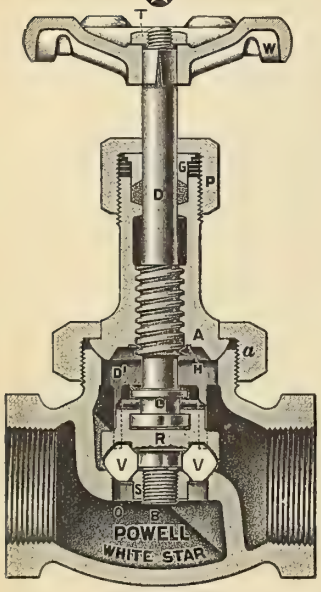
"Vapor-Tight" piston rings are described in a circular published by the Baker Valve Company, Minneapolis, Minn. "Much waste in engines comes from poor piston rings. Common snap rings cannot be kept tight. 'Vapor-Tight' rings when properly placed cannot leak. You will at once recognize the merits of the 'Vapor-Tight' ring and its advantages over other types. Notice the one-piece wearing surface, which eliminates all chance of scoring on account of loose couplers, segments or pins. The inner ring is so designed that it will always keep the split of the outer ring sealed. This means full power and fuel economy. When used in automobiles, gas and oil tractors 'Vapor-Tight' rings reduce carbonization to the minimum. Try a set of 'Vapor-Tight' rings in your motor and note the favorable results."

Vertical self-oiling engines are described in illustrated Bulletin No. 300, published by Engberg's Electric & Mechanical Works, 5 Vine street, St. Joseph, Mich. "Engberg engines and dynamos, direct connected, have been on the market for a period of approximately eighteen years. This service certainly requires a strictly first-class engine, an engine that is dependable, even when operating under most exacting conditions. However, owing to the constant demand we have had for engines for driving blowers, stokers, pumps, ash-handling equipment, etc., we have decided to also specialize on engine work only, because we can see the trade demands an engine of undisputable merits and something that will give continuous, efficient and dependable service. Going into this descriptive bulletin, you will see in Engberg engines nothing has been spared which would add to successful operation. Furthermore, you will find they have been most carefully and painstakingly designed on good, sound engineering principles. You will find the very best material for the purpose, while the general design throughout is positively unexcelled, as our many years of experience in the building of vertical, self-oiling engines enables us to know exactly what the trade demands, and we have made these engines with the idea in view of reducing complication; that is, simplifying construction in a general way as well as details, and still not sacrificing anything which would add to successful operation. These engines are constructed by the most modern methods, special designed tools being used to insure perfect workmanship throughout. We invite most careful inspection as well as investigation, because the general principles, as well as the smallest details, have never failed to attract the attention of the most critical buyer."

"White Star" Booklet on Request.

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(Especially The "White Star" Valve)



MR. ENGINEER:—

Here Are Five Good Reasons Why You Should Use Powell Valves Especially the "White Star" Valve

Because	First	A good salesman may make a first sale to you, but after that POWELL VALVES require little salesmanship.
Because	Second	POWELL VALVES sell themselves—they always make good on your pipe lines.
Because	Third	The Engineer who installs POWELL VALVES, especially the "White Star" Valve, eliminates all his valve troubles.
Because	Fourth	Engineers find our claims for POWELL VALVES to be as represented in our catalogue.
Because	Fifth	The world-wide demand for POWELL VALVES, Especially the "White Star" Valve, is based on superior quality, workmanship, and satisfactory results.

ASK YOUR DEALER FOR POWELL "WHITE STAR" VALVES OR WRITE US.

THE WM. POWELL CO.

DEPENDABLE ENGINEERING SPECIALTIES.

CINCINNATI, O.

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"How do you explain the remarkable fact that "for smokestacks, winches, anchors and all exposed metal and wood work above and below "the decks Dixon's Silica-Graphite Paint lasts "longer, and therefore costs less per year of "service, than any other protective paint."

MOTHER NATURE REPLIED:

"Because Dixon's Silica-Graphite Paint is not "a mechanical mixture of the silica and graphite. "It is Nature's mixture of the flake silica-"graphite, mined only by the Dixon Company "at an American Mine and used by them with "the highest grade of pure, boiled linseed oil "for over fifty years as their unrivalled paint "film. The Dixon Company also performs its "part. It makes no secondary grade. It "grinds the flakes to great fineness so that the "film will be adhesive."

Send for Booklet No. 75-B.

Made in Jersey City, N. J., by the

JOSEPH DIXON CRUCIBLE CO.

ESTABLISHED 1827

B-133

A reversible ratchet wrench is described in a catalogue published by Greene, Tweed & Company, 109 Duane street, New York. This wrench works with a quick, straight-ahead ratchet movement without lost motion. It has a socket form of head that encompasses the nut on all sides with equal bearing. It is claimed that slipping, which injures the nut, is impossible when this wrench is used.

The K-G torch is shown cutting through three steel-copper alloy plates, each plate ¾ inch thick and riveted together, in a picture in a catalogue just issued by the K-G Welding & Cutting Company, 556 West Thirty-fourth street, New York. "Start made without drilling hole or beginning at edge. Try this with your torch. How much gas and labor do you waste with imperfectly cutting torches?"

"The Right Way" is the title of a folder issued by the Leavitt Machine Company, Orange, Mass. There are two pictures in this circular. One illustrates the "old way" of repairing a steam valve, which took two men, and which consisted in removing the valve and putting in a new one, this operation costing from a few dollars to $50, or even more. The picture of the "right way" shows one man with a Dexter machine repairing a 3-inch valve in position, the operation taking only 10 to 15 minutes and the expense being trivial.

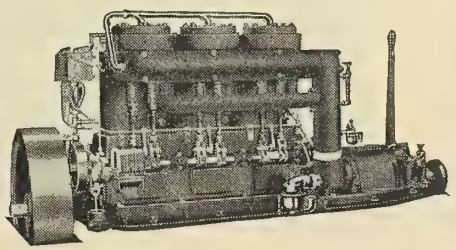
"Higher Superheat Means Greater Economy." This is the title of a bulletin published by the Locomotive Superheater Company, 30 Church street, New York. "As the degree of superheat increases the rate of coal saving increases. Condensation appears in the cylinders when superheat disappears. For the most economical operation superheat is therefore essential in every cylinder, and can only be obtained by high initial steam temperatures." An accompanying table, which was presented by Mr. Harry Gray before the Institution of Naval Architects, shows that 180 degrees of superheat is not enough to provide superheated steam in the low-pressure cylinder of a triple-expansion engine; the same condition applies when made for a quadruple expansion engine, and here 211 degrees of superheat is not enough. "Our firetube superheaters are capable of furnishing an initial superheat high enough to permit the completion of the expansion in all cylinders without condensation. Our latest bulletin shows how the savings of 12 to 20 percent in fuel may be made available for your ships. Where shall we mail your copy?"

Steam turbines and reduction gears are described in an illustrated catalogue just issued by the Moore Steam Turbine Corporation, Wellsville, N. Y. "The organizers and managers of the Moore Steam Turbine Corporation have had long experience in the design and manufacture of steam turbines, and there are embodied in the design of the Moore steam turbine the latest and best ideas in steam turbine construction known to the art. The Moore steam turbine has been developed to meet a demand for a highly efficient steam turbine in sizes from 5 to 1,000 horsepower. Designers and users of steam turbines have recognized for some years past that the most efficient type of steam turbine is what has come to be known as a combination type; that is, one type of turbine is used for the high-pressure part of the expansion, combined with another type for the low-pressure stages. A familiar example of this is the combination of a single velocity stage for the high-pressure element with Parsons or Rateau stages for the low pressure. The Moore single stage turbine consists of a single velocity stage, made up of a set of diverging expanding nozzles and a wheel carrying two rows of moving blades, with a set of stationary reversing vanes following the first row of moving blades. The single-stage steam turbine is the oldest type. Machines of this type were formerly built in this country in small sizes at speeds from 7,500 to 20,000 revolutions per minute, with reduction gears for reducing the speeds. This design was abandoned on account of an excessive amount of trouble with the gears and on account of the high rotation stresses, which were the cause of frequent and serious accidents, resulting in buckets being thrown out of the wheel, and in some instances rupture of the wheel itself. Notwithstanding this failure of the single-wheel type at excessive speeds, another manufacturer has recently brought out a turbine running at speeds up to 7,200 revolutions. A number of failures of wheels at this speed have already occurred, and the evidence points to what we believe will prove to be a fact, namely, that 7,200 revolutions is an excessive speed for any size of steam turbine. The policy of the Moore Steam Turbine Corporation will be to limit the speeds of our large turbines to 3,600 revolutions per minute, and of the smaller sizes to 5,000 revolutions per minute as a maximum, and to obtain the required steam consumption by multi-staging if necessary. By this means the rotation stresses will be kept at a low figure, affording a larger margin of safety, a very important feature, and one which should not be lost sight of by the prospective purchaser."

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THE MOTOR WITH THE BORE and STROKE

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Ward Liner S. S. "Havana," re-equipped with Welin Quadrant Davits and our steel keel lifeboats;
order also received to re-equip her sister ship "Saratoga."

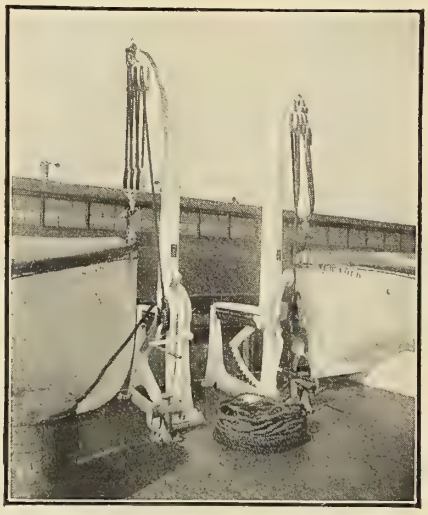
WELIN DAVITS AND LIFE BOATS

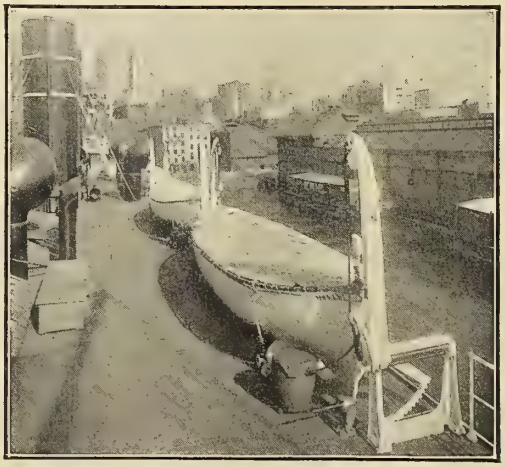
Form the Backbone of All Life-Saving Equipment

They last as long as any ship and in many cases are taken off old ships and used again.

They Have Rightly Won The Name

WELIN "LONG-LIFE" EQUIPMENT





Boat deck on S. S. "Havana".

WELIN MARINE EQUIPMENT CO.

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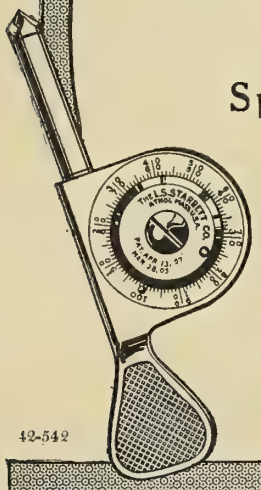
London House: 5 Lloyds Avenue, London, E. C.

How Fast is it Turning?

—a vital factor that you need to know about your auxiliary engines and turbines; or motors, generators, etc. Engines or motors which run faster than required, are needlessly overworked — serious troubles often result. How fast are *your* auxiliaries turning—do you know? To save trouble and expense, the cheapest and most accurate way to tell is to test with a

Starrett

Speed Indicator



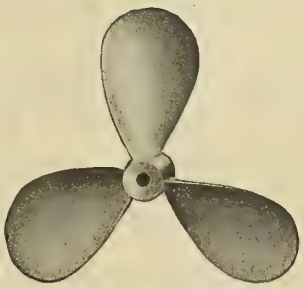
These indicators have many other uses—great assistance in figuring pulley sizes and computing horse power. Starrett Speed Indicators can be used on any shaft, no matter how centered. Write for our catalog No. 21L, describing 2100 styles and sizes of fine tools and hack saws.

The L. S. Starrett Co.
— World's Greatest Tool Makers
ATHOL MASS.

42-542

Spare's Manganese Bronze Propellers

Thin-bladed
Strong
Tough
Light
Non-corrosive



All Sizes
10 inches
to
20 feet
in Diameter

Unequalled for lasting Qualities and Efficiency

Write for Particulars

ALSO SOLE MANUFACTURERS

—DYSON—

STANDARD MOTOR BOAT PROPELLERS

American Manganese Bronze Co.
3431-3529 Rhawn St., Holmesburg, Phila., Pa.

Cyclone hoists are described in Catalogue No. 69, just published by the Chisholm-Moore Manufacturing Company, Cleveland, Ohio. All gears are cut from solid blanks. The bearings are of graphite bronze or roller bushed. Sizes ½ to 40 tons.

"The Electric Rudder Indicator" is the title of Bulletin No. 40, which has just been published by the Electro-Dynamic Company, Bayonne, N. J. "The application of electrical energy for various uses on board ship has made rapid strides during the last ten years, and not only are all modern ships lighted by electricity, but most of the auxiliary machinery is now driven by electric motors, and much of the signaling is also accomplished by the use of this agent. There was a time when ship owners, and the operating force of same, had considerable mistrust against electrical apparatus, fearing unreliability, but time has proven that such fears were ill-founded, and the use of electricity on board ship is gaining from year to year. Some years ago this company put upon the market an electrical rudder indicator which wherever installed has given perfect satisfaction. Owing to some other development in the electrical line which absorbed the full capacity of our factory, the electrical rudder indicator was crowded to one side for a time, but continued inquiries and repeat orders have convinced us that it is too good a device for this state of affairs to continue."

Steam specialties are the subject of a profusely illustrated cloth-bound catalogue of 222 pages, which has just been issued by the American Steam Gauge & Valve Manufacturing Company, 208 Camden street, Boston, Mass. This company is a manufacturer of gages, valves, indicators, steam traps and kindred appliances for governing indicating, measuring, recording and controlling steam, water, air, gas, oil, ammonia and all other pressures. The introduction to this catalogue, which will be sent to any of our readers upon request, is as follows: "It is with much pride that we present to our friends and patrons this, our No. 65 Catalogue, and are able to point to the fact that it commemorates the sixty-fifth anniversary of our business existence, which was established in 1851. Operating our modern plant, the largest of its kind in the world, our products have earned for themselves an enviable reputation, and we need no further introduction to the trade. This general Catalogue No. 65 supersedes our edition of 1908, and all other catalogues, price lists or pamphlets covering material manufactured by us issued prior to the date given below. Gages, valves, etc., will be furnished according to style and dimensions as given in this catalogue. If goods are wanted different from those shown, they will have to be made to order at special prices, which will necessarily be higher than prices on regular goods. It will be particularly noted that there are a number of changes in list prices as compared with any previous editions, and also that a number of important specialties have been added. Each item has been given a separate figure number, and it is particularly requested that in all correspondence, inquiries and orders, reference be made to Catalogue No. 65 and figure number of particular item or items."

"Sturtevant Power Apparatus" is the title of Bulletin 213 just issued by the B. F. Sturtevant Company, Hyde Park, Boston, Mass. "Sturtevant power apparatus, fully developed, well designed and efficient, covering a wide range of application, is already well known both in this country and abroad. For more than half a century the name Sturtevant has been synonymous with excellence and efficiency in the matter of apparatus for handling air and gases. Later developments in the line of engines, turbines and economizers followed the standard established in the case of fans and blowers. Irrefutable proof of the acknowledged quality of Sturtevant power apparatus is furnished by the list of users. The great lighting and power companies of New York, Boston, Chicago, Cleveland and many other cities, the mammoth plants of the Steel Corporation, paper mills, textile mills and miscellaneous manufacturing establishments without number, have for years used Sturtevant fuel economizers and mechanical draft apparatus. Repeat orders, coming time after time from these discriminating buyers, signify satisfaction and furnish evidence of the excellence of Sturtevant products. On the sea, also, our apparatus has found wide application, as is indicated by numerous installations of electric generating sets and forced draft equipment on ships of the United States navy. Our engineers, who are specialists in their line, are at your service at all times for consultation and advice. It is the purpose of this book to give a general description of the complete line of Sturtevant power apparatus. Special bulletins describing each particular product are published, and a list of such publications will be found on page 27. These will be sent on request and a return postcard has been inserted for the convenience of those desiring this detailed information."

"1500 Good Tools" is the title of a booklet just issued by the Goodell-Pratt Company, Greenfield, Mass. "The tools shown in this booklet are just a few of Goodell-Pratt's useful household tools—tools that should be in your home, as they will pay for themselves many times in the saving of repair bills. Goodell-Pratt tools are made primarily for mechanics. This means that they are better tools than are ordinarily made for popular or home use. A good mechanic never economizes on tools. He cannot afford to, for the quality of his work, and therefore his reputation, depend very largely on the kind of tools he uses. We can make no stronger statement than this: mechanics the world over know, use and praise Goodell-Pratt tools. All Goodell-Pratt tools are fully guaranteed. You can buy any of the tools here listed at most hardware stores, but if you find any difficulty in getting what you want, we will gladly supply you direct, prepaying carriage charges unless otherwise stated under price quoted."

In issuing its October *Monthly Stock List,* the Bourne-Fuller Company, Cleveland, Ohio, makes the following statement: "In issuing from month to month our stock list of materials on hand for immediate shipment, it is our purpose to have the list as accurate as possible and representative of the condition of our stocks. However, the daily shipments from same result in constant fluctuations in the stocks, and due to the present unusual demand following delayed deliveries from the mills, the fluctuations are at this time greater than usual. At the same time, our stocks are being constantly replenished; and while we may be short or out of certain items at the time reference is made to the list, we will also probably have on hand material in addition to that shown in the list. We will appreciate, therefore, inquiries for prompt warehouse shipments of any or all sizes usually carried; but for reasons mentioned above, we must ask the trade to appreciate that the list as issued is necessarily subject to change, and that the materials are offered subject to prior sale."

The Duntley Universal electric hammer drill is described in Bulletin E 43, just published by the Chicago Pneumatic Tool Company, 1026 Fisher building, Chicago, Ill. "A large number of these tools are in successful operation, and the design and construction has been demonstrated to be most satisfactory. The tools are in extensive use in drilling stone and concrete within the capacity of the tool, as well as for light chipping. The tool is equipped with a universal motor (patents covering which as applied to portable tools are controlled by this company), and will operate interchangeably on direct or alternating current. It is simply necessary to have the motor wound for the correct line voltage on which it is intended to operate. The hammer blow, which is delivered by a piston on the drill steel or chisel, is produced by pneumatic impact, and is very effective. At the instant the blow is struck the piston is running free of all mechanical parts, and therefore no shock or vibration is transmitted to the electrical parts of the tool. This means that there is no tendency for the electrical wires or connections to be crystallized due to incessant jarring. The tool is well balanced, and when held loosely in the hand the line of center of gravity falls between the third and middle fingers of the hand, and lies within the barrel of the tool, allowing the tool to hang vertically. A thumb-switch, conveniently located in the handle for the control of the electric circuit, is manipulated the same as in the well-known pneumatic hammers. All bearings are of the ball type, provision being made for the lubrication of all revolving and reciprocating parts. The gears and those portions of the moving parts subject to wear are all hardened. When drilling holes in stone or concrete in a downward position the powdered cuttings collect rapidly, and not only absorb and waste much of the force of the blow, but tend to choke up the hole, making it difficult to remove the drill bit. A special feature of the Duntley electric hammer drill is the live air device for clearing the hole of the cuttings while drilling. This makes it possible not only to deliver the full force of the blow on the solid stone or concrete, but the removal of the drill bit is accomplished without difficulty, as there are no cuttings left in the hole to interfere. Hollow steels for this purpose are furnished, as shown in the table on the opposite page."

ASHTON Pop Safety Valves The Quality Standard

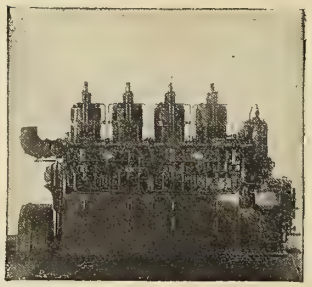


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STANDARD GAS ENGINE COMPANY, SAN FRANCISCO
Exclusive Pacific Coast Representatives

The Mundy high-speed cargo winch for marine work—steam, electric or gasoline—is described in Catalogue A, published by the J. S. Mundy Hoisting Engine Company, Newark, N. J. The manufacturer states that the Mundy engine is the pioneer friction-drum hoisting engine, and that years of careful study of the requirements peculiar to the marine field have made it especially adapted to the work for which it is designed. Among the advantages claimed are quick starting, perfect control, rapid operation and low installation and operating costs.

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BOLINDER'S

BOLINDER'S U.S.A. INSTALLATIONS

NAME.	Type of Vessel.	DIMENSIONS. Length.	Breadth.	Depth.	Tons—D. W.	Power, B.H.P.	Speed—Knots.
Vacuum Oil Co.	Tanker	306′	47′	28′	4500	1650	11
Pierce Oil Corp.	"	306′	47′	28′	4500	1650	11
Building	"	306′	47′	28′	4500	1650	11
"	"	306′	47′	28′	4500	1650	11
Chas. R. McCormick	Schooner	276′	48′	21′	3500	640	8½
"	"	276′	48′	21′	3500	640	8½
"	"	276′	48′	21′	3500	640	8½
Manitowoc Shipbldg Co.	"	261′	40′6″	23′	3000	640	9
"	"	261′	40′6″	23′	3000	640	9
A. O. Anderson & Co.	"	246′	44′	22′	2600	640	9
"	"	246′	44′	22′	2600	640	9
The Texas Co.	"	259′5″	45′3″	22′9″	3500	640	8½
E. K. Wood Lumber Co.	"	210′	42′	15′	1800	640	9¼
C. & O. Lumber Co.	"	175′	42′6″	18′		640	
W. R. Grace & Co.	Motorship	225′	42′6″	15′	2100	640	8½
"	"	225′	42′6″	15′	2100	640	8½
"	"	235′	42′6″	16′		640	
"Svaland"	Schooner	300′	42′	24′4″	4000	640	
A. O. Anderson Co.	"	192′	41′3″	21′	1500	480	8½
Standard Oil Co.	"	261′	43′	23′6″	3200	320	7
"	"	261′	43′	23′6″	3200	320	7
"	"	261′	43′	23′6″	3200	320	7
"	"	261′	43′	23′6″	3200	320	7
"	"	261′	43′	23′6″	3200	320	7
"	"	261′	43′	23′6″	3200	320	7
Standard Transp. Co.	Tanker	197′3″	35′	14′4″	1600	320	7½
Pendleton Bros	Schooner	255′	43′	22′6″	3000	320	
"	"					320	
Inter-Island Steamship Co.	Motorship	147′2″	30′	12′5″		320	
Andrew Mahoney	Schooner	225′	43′	20′3″	2700	320	6¾
"	"	225′	43′	20′3″	2700	320	6¾
"	"	225′	43′	20′3″	2700	320	6¾
Bucyrus Co.	Dredge					320	
Taylor Engineering Co.	Schooner	225′	44′	23′	2250	320	7
"	"	225′	44′	23′	2250	320	7
"	"	225′	44′	23′	2250	320	7
"	"	225′	44′	23′	2250	320	7
"	"	225′	44′	23′	2250	320	7
"	"	225′	44′	23′	2250	320	7
"	"	225′	44′	23′	2250	320	7
"	"	225′	44′	23′	2250	320	7
Matson Navigation Co.	"	212′	34′	21′6″	1700	320	8
R. P. Rithett	Bark	206′	38′	19′	1850	320	7½
Shell Oil Co.	Tanker	211′	34′	19′6″	1800	320	7¼
W. R. Grace & Co.	Schooner	170′	38′8″	9′8″	800	320	8½
W. & S. Job & Co.	"	210′	40′	19′	2100	320	7½
J. B. King & Co.	Barge	220′7″	35′	21′	1900	320	7
"	"	220′7″	35′	21′	1900	320	7
"	"	220′7″	35′	21′	1900	320	7
"	"	220′7″	35′	21′	1900	320	7
"Carmela"	Bark	262′	37′6″	22′	2200	320	7
Chas. R. McCormick	Schooner	230′	44′	19′		320	
R. Lawrence Smith	"	236′	40′	19′	2000	320	7
Pacific Commercial Co.						320	
Honolulu Iron Works		124′	25′	9′		240	
W. & S. Job & Co.	Schooner	153′8″	28′3″	12′4″	550	160	7
Borden & Lane	"	138′	32′	13′	600	160	7¾
"Marie L. Hanlon"	Tug	71′5″	17′8″	7′5″		160	9¾
A. J. West	Schooner	161′	40′	11′6″	1050	160	6
"Eclipse"		104′	27′	14′	500	160	7¾
"Pilar"	"	148′	32′		850	160	6½
"Gracie S"	Pilot	83′	24′7″	10′2″		120	9
W. & S. Job & Co.	Schooner	122′5″	24′	13′	400	100	6½
"Gilbert Islands"	"	125′	31′	11′9″	650	100	6
"Chiriqui"	"	110′	24′	8′	200	100	6½
"Ocmulgee"	Riverboat	120′	24′	5′	90	100	8¾
F. A. Scharberg	"	97′	19′6″	8′		100	

Total B.H.P. Marine Engines.... 29,060

In addition to above OVER 10,000 B. H. P. stationary and smaller marine engines installed throughout U. S. A.

BOLINDERS CO.

30 CHURCH ST. NEW YORK

"Characteristics of National Pipe," "National Bulletin No. 12" and "National Stationary and Marine Boiler Tubes" are the titles of some valuable bulletins published by the National Tube Company, Pittsburg, Pa. Copies of any of these publications will be sent to any of our readers who will write to the National Tube Company and ask for them, at the same time mentioning THE BOILER MAKER.

A double-end punch and shear is described in Catalogue O-1060 published by Bertsch & Company, Cambridge City, Ind., This machine is described in the catalogue as a double-end punch and shear with 60-inch throats, capacity 1¼ inches through 1-inch and shearing 1-inch plates. Made in all standard sizes.

"Oxy-acetylene welding is so universally useful in metal joining operations of all kinds that many shops have become accustomed to specify welding instead of riveting." This is the statement made in a circular published by the Prest-O-Lite Company, 818 Speedway, Indianapolis, Ind. One of the illustrations in this circular is a picture of some large vats for holding unusually searching chemical solutions, made by welding all seams by the Prest-O-Lite process. The result is that the welded joints are leak-proof. The catalogue states that all the splendid advantages of oxy-acetylene welding and cutting are practically doubled through the portability, economy, simplicity and efficiency of the Prest-O-Lite process.

Gages, taps and dies are the subject of a profusely illustrated catalogue of 270 pages which has just been published by the Greenfield Tap & Die Corporation, Greenfield, Mass. In addition to describing and illustrating dies, taps and gages of every conceivable variety, there are 40 pages of miscellaneous tables and information, including a glossary of terms; tables of United States Standard Threads, Tap Drilling Sizes; British Standard Fine Screw Thread; the Metric Screw Thread; the A. S. M. E. Screw Thread; Metric and English or American Equivalent Measures; Millimeters and Equivalent Decimals and Inches; Tapped Hole Limits for Machine Screw Taps, etc. A copy of this interesting and valuable catalogue will be sent to any of our readers free upon request.

"The Seabury Watertube Boiler for Stationary and Marine Service" is the title of a profusely illustrated catalogue of 48 pages which has just been published by the Boiler Department of the Gas Engine & Power Company and Chas. L. Seabury & Company, Con., Morris Heights, N. Y. "The Seabury safety watertube boiler is designed to meet the requirements of a light-weight boiler occupying a minimum of floor space per horsepower, besides possessing, to the highest degree, all the essential qualities and attributes of safety. Its simplicity of construction must appeal to all fair-minded engineers, especially as this simplicity tends to materially increase efficiency and durability. All the pressure elements throughout the Seabury safety watertube boiler, whether of the stationary or marine type, are kept as small as is consistent with good designing, thus making it an exceptionally safe steam generator. By comparing the steam drum of a Seabury boiler—its largest pressure element—with the large drums, many feet in diameter, in the shell and Scotch types of boilers, the claim of greater safety is at once apparent. A large number of Seabury boilers are to be found in both stationary and marine service. Boilers intended for stationary and commercial marine work, where weight is not an essential factor, are of heavy construction, with large steam drums and generating tubes. Steam domes are also added when required. High-speed yacht boilers are constructed with small drums and generating tubes, so as to economize in weight. Standard Seabury boilers are designed with a single steam drum connected to two lower or mud drums—one on each side—by two nests of bent tubes enclosing a large combustion chamber. The tubes are staggered so as to present the greatest amount of direct heating surface, and are also so arranged as to facilitate their cleaning by means of a steam jet and hose. When given ordinary care renewal of tubes will not be necessary for many years, and then, when found necessary, a tube can be replaced in a very short time. The two nests of tubes to the right and left of the combustion chamber, with their baffling walls, together with the feed water heater—when supplied—running crosswise over each nest of tubes, interpose an efficient heating surface from which the maximum amount of heat is extracted. We will furnish test data where required from our records of such tests as conform to the character of service which the contemplated boilers are to perform. It will readily be appreciated that the conditions of operation would greatly affect the result, so that we have adopted the policy of furnishing, upon request test data from boilers performing service similar to that intended."

"Enthusiastic? Why of course we are!" says the Ford Chain Block & Manufacturing Company, 130 Oxford street, Philadelphia, Pa., in a catalogue describing its "Tribloc" chain hoists. The company states, "We build the 'Tribloc' the best we know how, sell it a fair price and stand back of it every minute."

BUSINESS NOTES

THE MASSILLON FOUNDRY & MACHINE COMPANY, Massillon, Ohio, will increase its capital stock from $100,000 to $300,000, for the purchase of a site and the erection of a new plant, which will be 100 by 300 feet, of brick and steel, and located near the plant of the Central Steel Company.

A COUPLE OF RECOMMENDATIONS for Jeffrey's marine glue. A customer sends L. W. Ferdinand & Co., 152 Kneeland street, Boston, Mass., a photograph of a canvas-covered lap-streak rowboat, and writes that this boat was bought from O. Sheldon & Company in 1891; was covered with canvas laid in Jeffrey's No. 7 black soft quality marine glue by his father in 1892. "The boat has been re-ribbed and a new gunwale put on but has never leaked a drop. The hull is almost as good as ever. The wonderful thing about this boat is that it is lap-streaked and yet the glue has held ever since it was put on and is still holding to-day as good as ever. The boat has been in service from two to four months every year, and has always been pulled up on the beach. You can realize the wear on the canvas under such conditions. She has had service—hard service—and yet to-day she stands in a class by herself. We keep the canvas well painted; this, combined with the Jeffrey's marine glue used, is the whole secret." Another customer, a well-known yacht designer, writes: "Relating to Jeffrey's No. 1 black extra quality marine yacht glue, I am thoroughly familiar with this excellent material. I have used it for more than thirty years, beginning when it was little known in this country. I am not now engaged in building, but I recognize its value for various classes of work. I note that you claim for it a duration of four to six years; I used it in the deck seams of a small yacht in 1903, and I find it is still in very good condition."

MARINE REFRIGERATION.—Since last reported the Brunswick Refrigerating Company, New Brunswick, N. J., has sold the following plants: One-ton refrigerating and water-cooling plant to the Bull Insular Steamship Company, for the steamship *Moldegaard*.

To Mr. Allen K. White for the yacht *Absegami*, a ¼-ton plant.

To the Sun Shipbuilding Company, two 2-ton plants for hulls No. 1 and No. 2, now being built by them.

To the Petroleum Transport Company, a 1-ton plant for the steamship *Norman Bridge*.

To the Prince Line, a 1-ton plant for the steamship *French Prince*. This is the fifteenth machine sold to this company.

To the United States Coast and Geodetic Survey, a 2-ton plant for the steamship *Surveyor*, now being built at Manitowoc, Wis.

To the Baltimore Dry Docks & Shipbuilding Company, a 1-ton plant for hull No. 75.

To the Bull Insular Steamship Company, a 1-ton plant for the steamship *Dade*.

To the Ocean Steamship Company of Savannah, a 2-ton plant for the steamship *City of Savannah*. This is to form a duplicate unit on this steamer, which is now being overhauled at Robin's Dry Dock after having been sunk at Delagoa Bay.

To the Chester Shipbuilding Company, Chester, Pa., 1-ton plants for hulls No. 348, No. 351, No. 352 and No. 353.

Those interested in marine refrigeration will profit greatly by securing a copy of a new booklet issued by the Brunswick Refrigerating Company, entitled "Dividends from Waste." This will gladly be sent upon request, by addressing the Brunswick Refrigerating Company, Marine Department, New Brunswick, N. J.

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Completely equipped machine shop.

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"Marine Glue—What to Use and How to Use It"
We would esteem it a privilege to answer any question that may arise in regard to this material.
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No advertisements accepted unless cash accompanies the order.

Advertisements will be inserted under this heading at the rate of 4 cents (2 pence) per word for the first insertion. For each subsequent consecutive insertion the charge will be 1 cent (½ penny) per word. But no advertisement will be inserted for less than 75 cents (3 shillings). Replies can be sent to our care if desired, and they will be forwarded without additional charge.

Position as ship and engineer surveyor to Norwegian Ceritas in the United States is vacant for an engineer with theoretical and practical training. For further particulars apply to *Norwegian Veritas Office,* 17 State street, New York.

Marine engineer open for engagement as chief draftsman or assistant to chief engineer. Technical graduate; mechanical designer of wide experience; member A. S. M. E. At present employed in responsible supervisory position in shipyard. Address *Technical,* care of MARINE ENGINEERING.

Shipbuilder and naval architect, 33, is open for position with shipyard or steamship line. Sixteen years' shipbuilding experience on new and repair mercantile work; technical training; thorough, practical constructionist; mold loft and yard experience in all branches; tactful, resourceful and well up in latest improvements. Isherwood system, self-trimmers, oil tankers, freighters, dredgers and small craft. Address *Constructionist,* care of MARINE ENGINEERING.

Electrical-Mechanical Engineer, 37, is available for engagement by shipyard or steamship company requiring competent superintendent or inspector; thoroughly familiar with ship construction, layout, installation and maintenance electrical systems and A. C. and D. C. electrical apparatus. Also familiar with forced ventilation and heating systems, auxiliary machinery, such as pumps, windlasses, steering gears, etc. Eleven years present position at one of largest shipyards on the Delaware; want chance to expand; highest credentials; salary, $2,500 to $3,000, dependent on location. Address *Electrical Engineer,* care MARINE ENGINEERING.

TWO NEW STEEL FREIGHTERS FOR SALE

410 ft. x 54 ft. x 29 feet; 24.2 draft; 8800 tons dead weight; 100 A-1 Lloyds. Speed 10½ knots. 3 Scotch boilers. Engines, oil. Turbine 2500 I. H. P. First delivery 15 months; second delivery 17 months.

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One capable of lifting about 1,500 tons. Address with full information, Floating Dock, care of Marine Engineering, 461 Eighth Ave., New York.

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29 West 39th Street, New York City.

UNITED STATES NAVAL INSTITUTE
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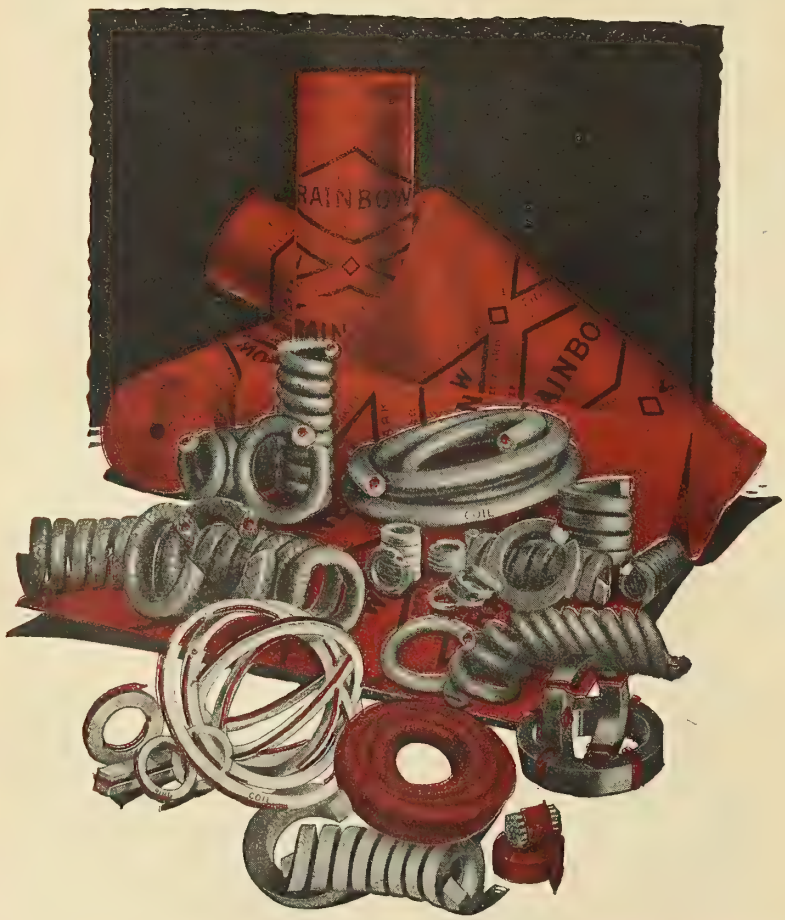
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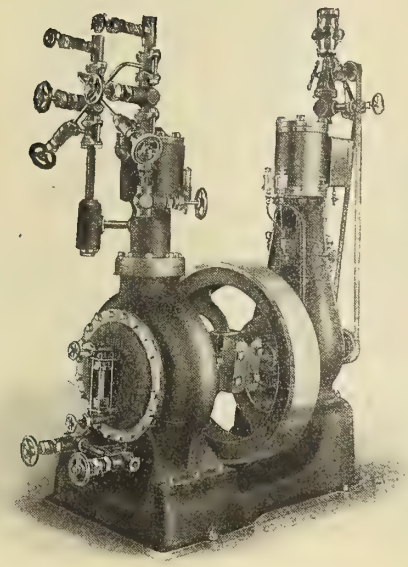
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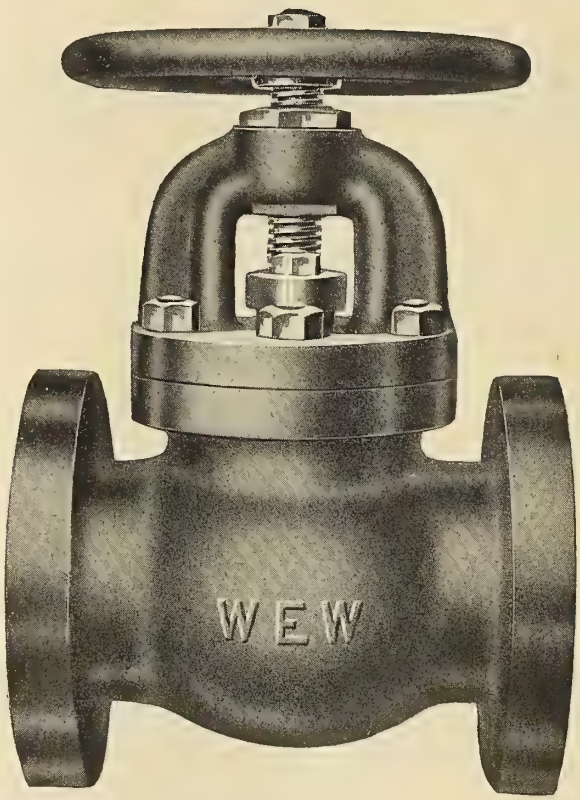
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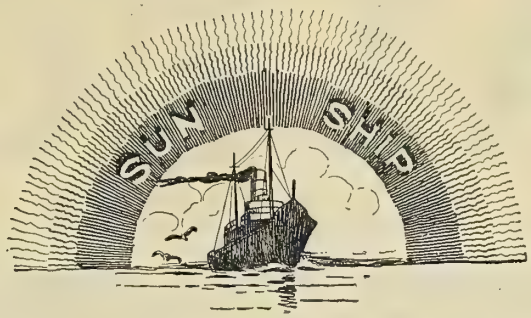
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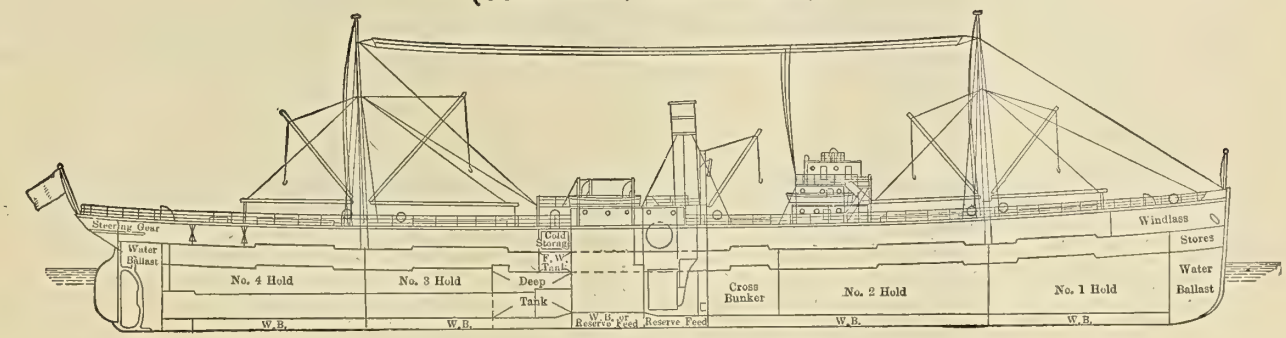
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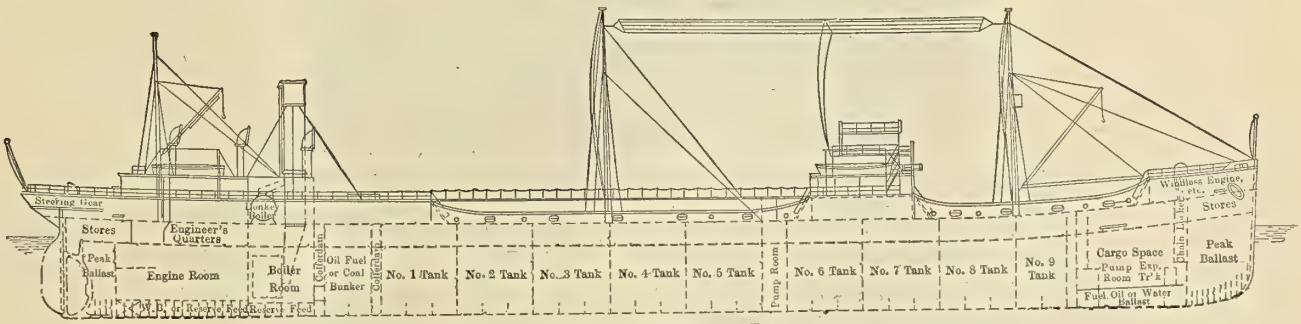
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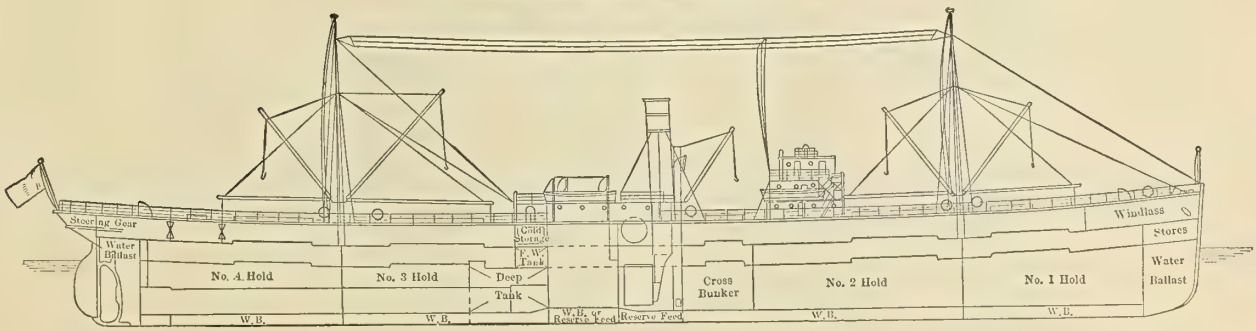
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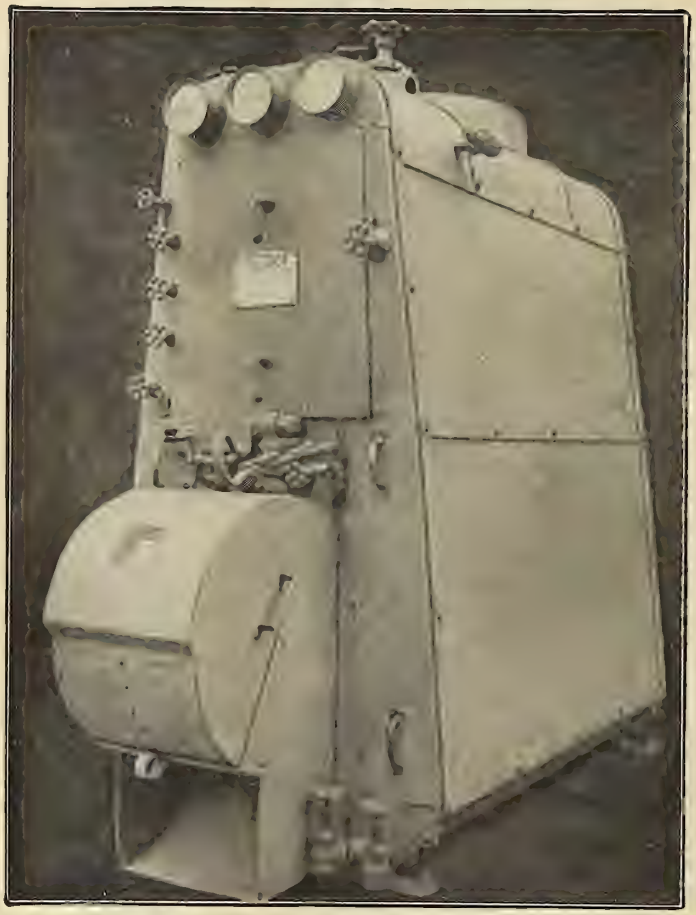
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FUEL USED—Talbot boilers use the cheapest grade of crude or fuel oil. May we send you our "Bulletin A?"



The steam launches on both the battleships "Arizona" and "Pennsylvania" are equipped with Talbot boilers. Talbot boilers have been in use in the Navy for several years.

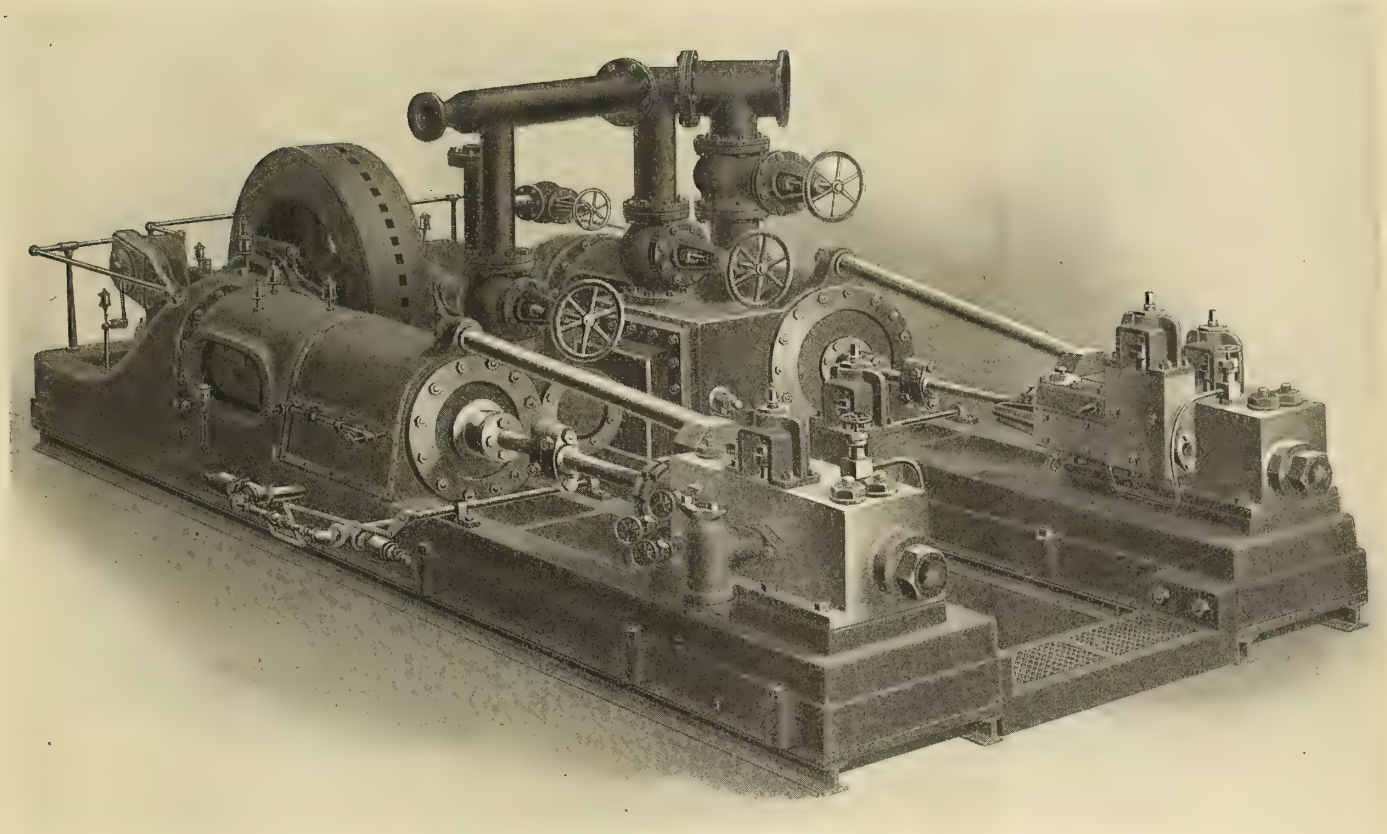
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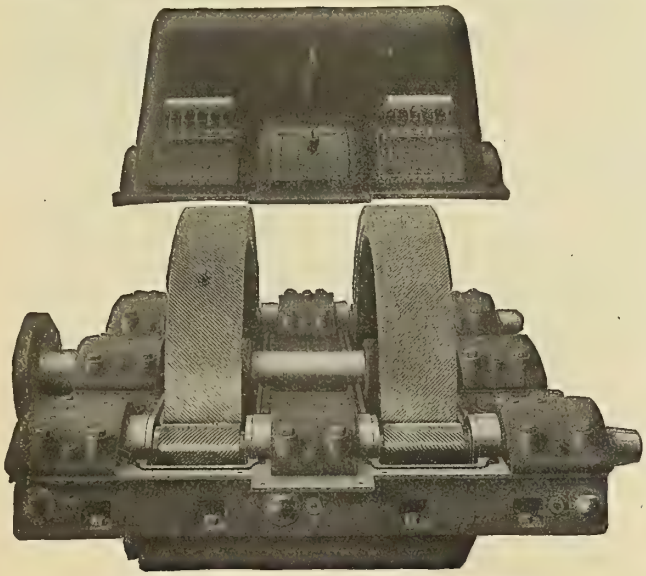


This Bureau supervises the construction of vessels throughout under established Rules, tests all materials for Hulls, Machinery and Boilers, and proof tests all anchors and chains, etc.

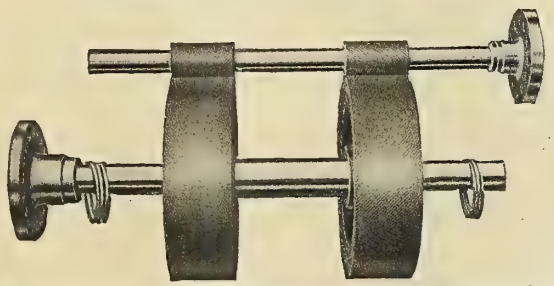
It issues for vessels, a Certificate of Classification, which is a receipt for Builders, a guaranty for Owners, an authority for Underwriters and a business guide for Shippers.

De Laval Speed Reducing Gears Are Properly Cut And Properly Supported

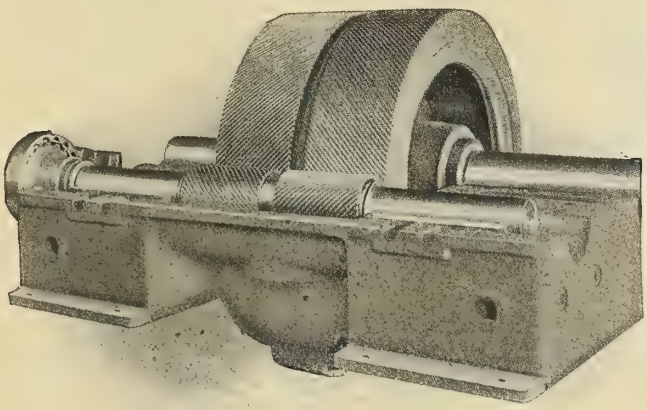
The high speed of steam turbine speed-reducing gears requires absolutely continuous transmission of force from one metallic tooth face to the other. To secure uniform angular movement of both driving and driven parts, and to prevent shock and vibration, the gear teeth must be cut with the utmost precision and the gear and pinion must be so supported that there will be perfect interaction.



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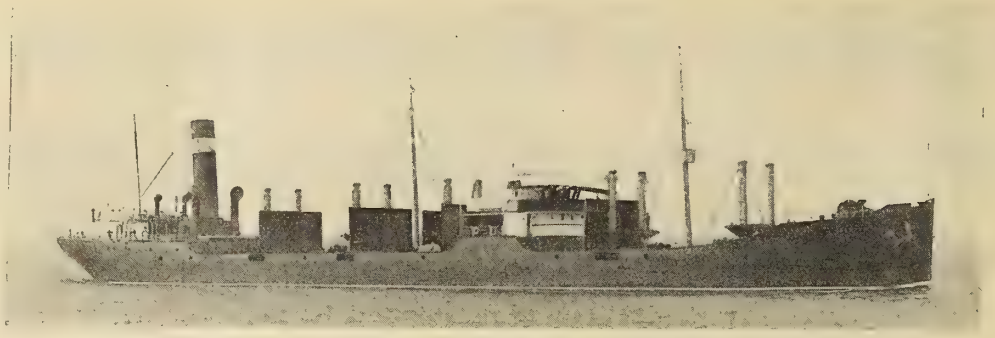
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This Steamer, on July 11th, 1916, loaded a full cargo of coal at Louisburg, Cape Breton.

When loading and bunkering was completed and the vessel ready for Sea the Mean Draft, as shown by the Pneumercator, was 23′–4½″ and the Total Deadweight 8,080 tons.

The Bunker Coal, Fresh Water and Stores on board were carefully measured and checked, same being as follows:

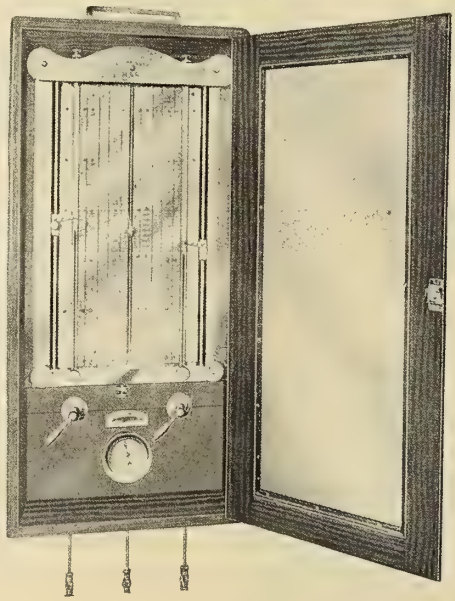
Bunkers on board before loading	250 tons
" taken at Louisburg	254 "
Fresh Water on board for Boiler use	110 "
" " for domestic use	13 "
Stores, etc	25 "
Total	652 "

Deducting this from 8,080 Tons Deadweight the Cargo, as per Pneumercator, was 7,428 tons.

After the Cargo was discharged at Boston on July 14th, it was carefully weighed by the consignees and the weighing checked by a representative of the shippers of the cargo.

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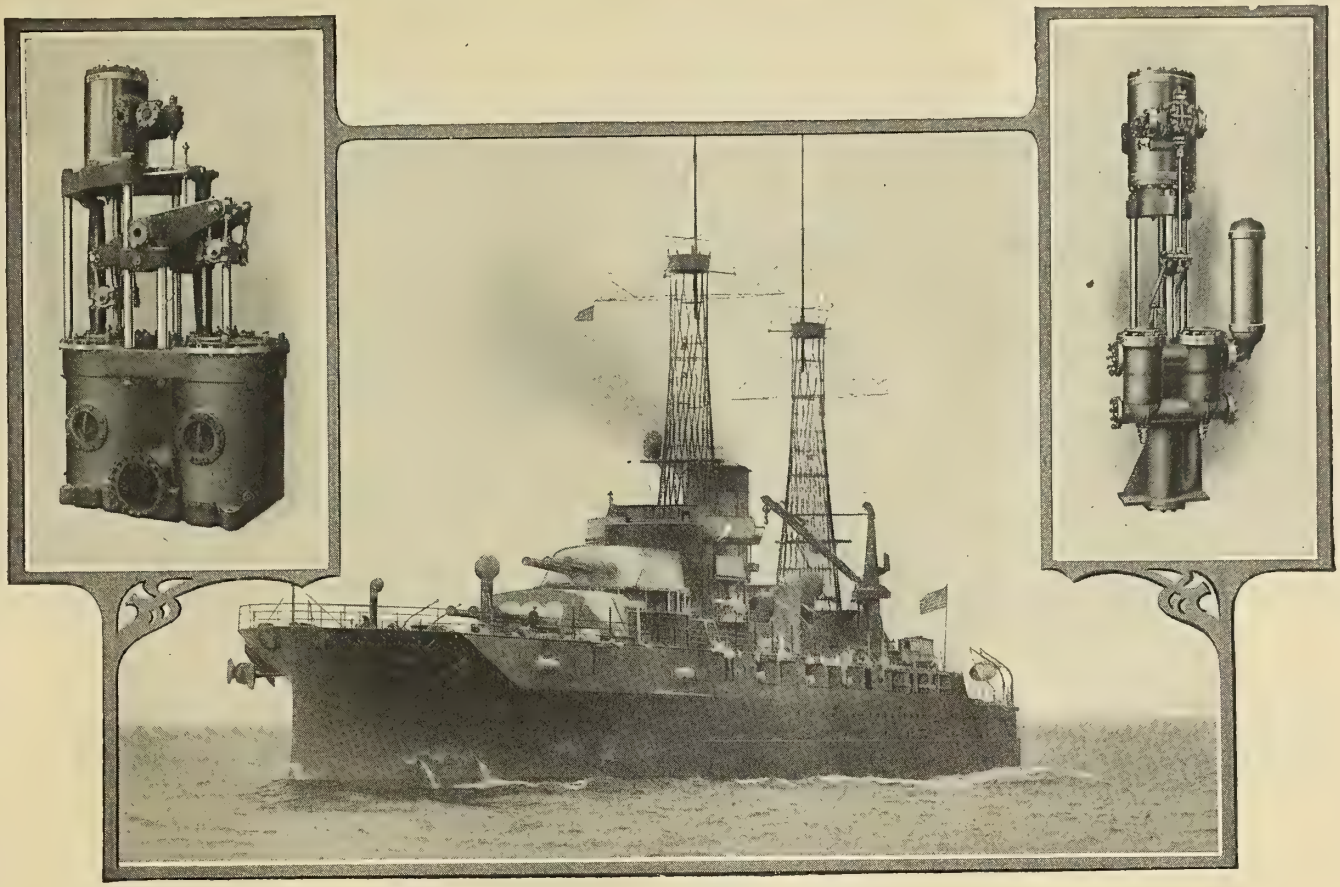
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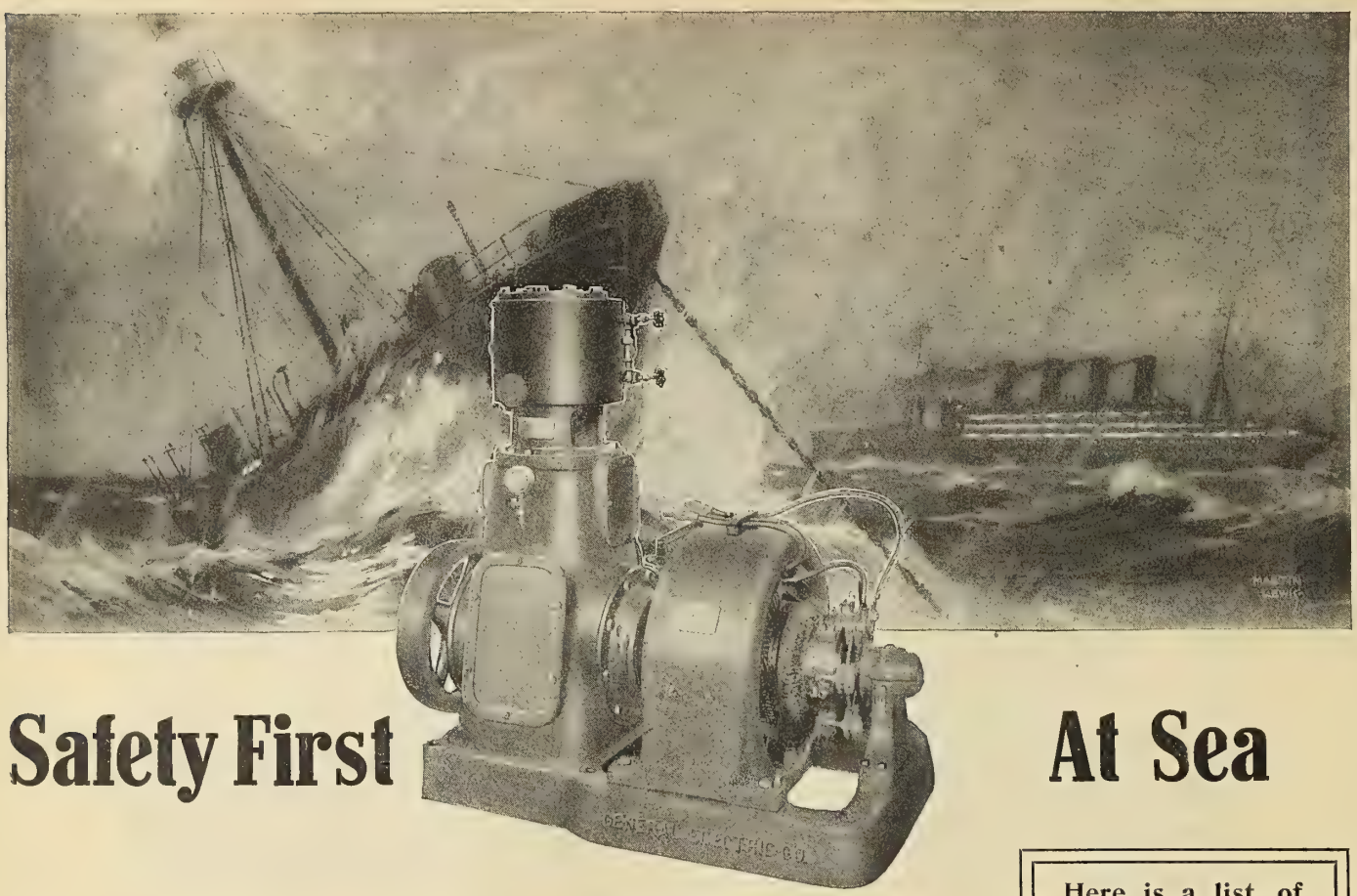
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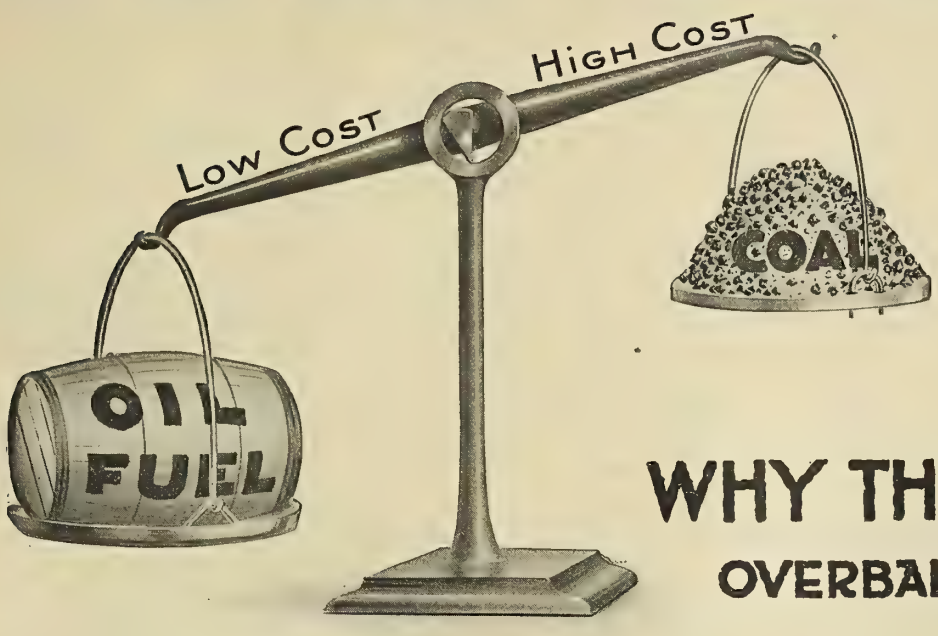
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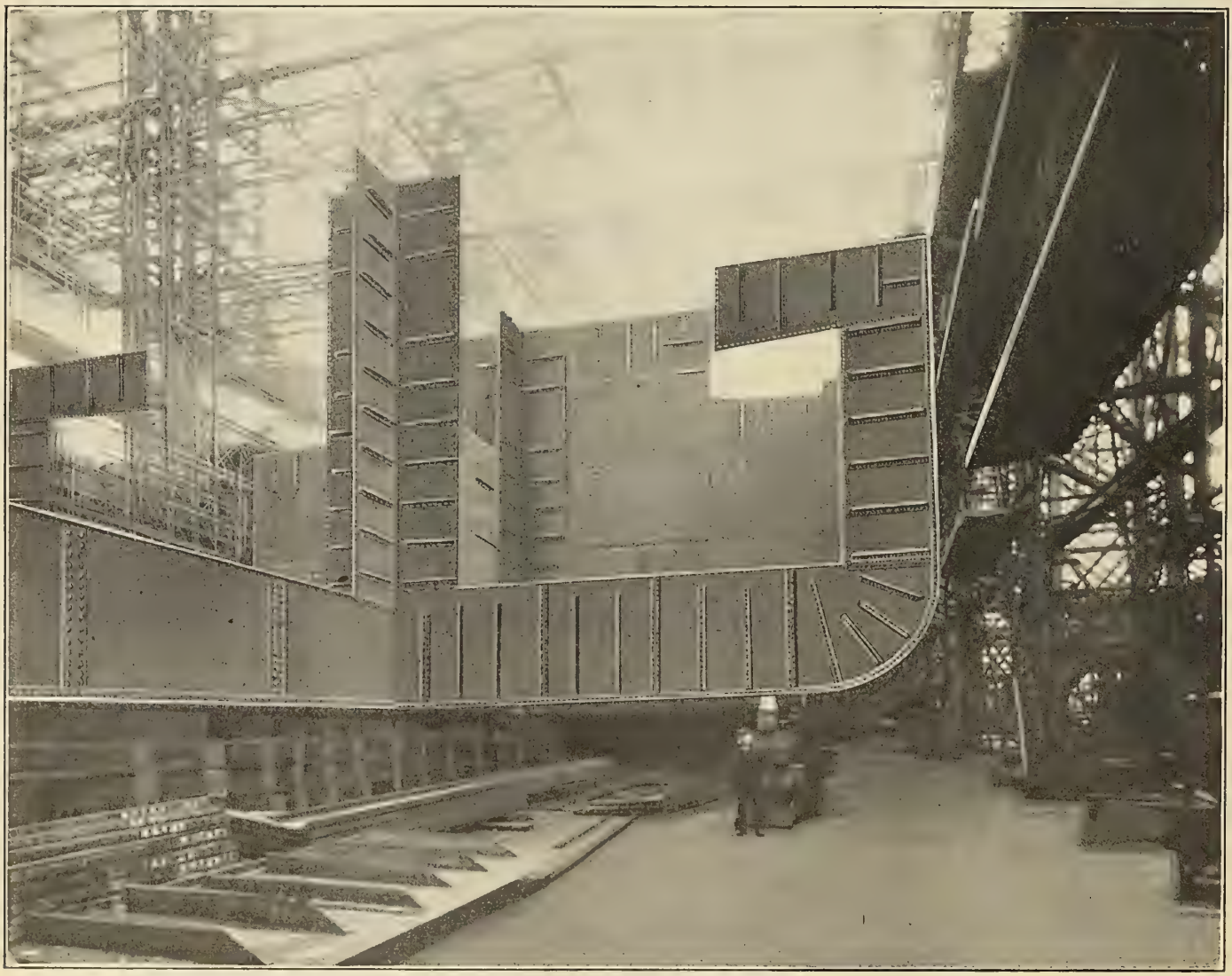
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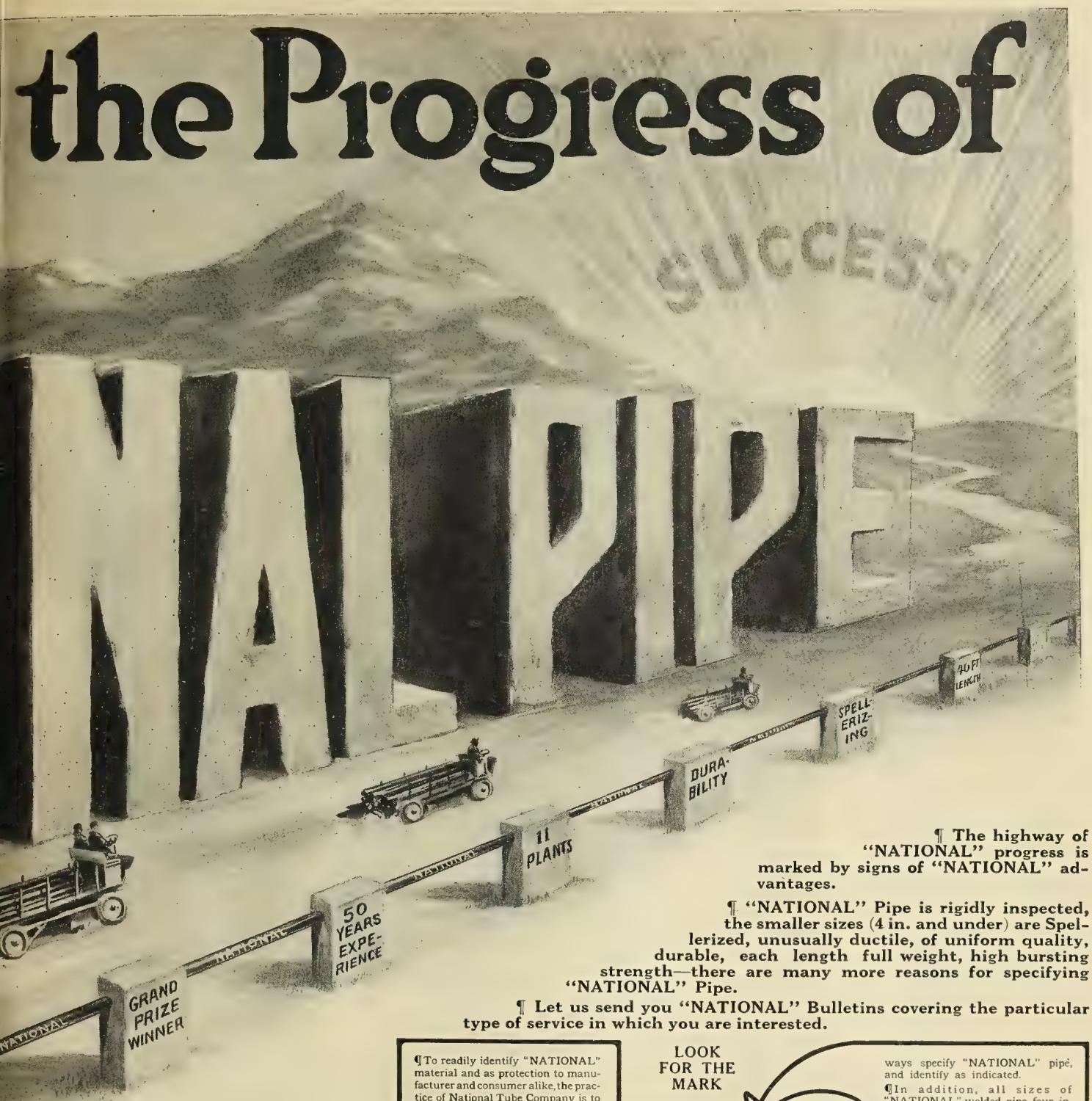
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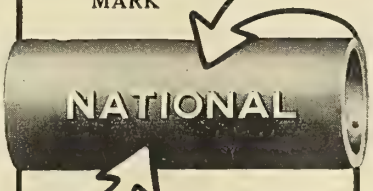
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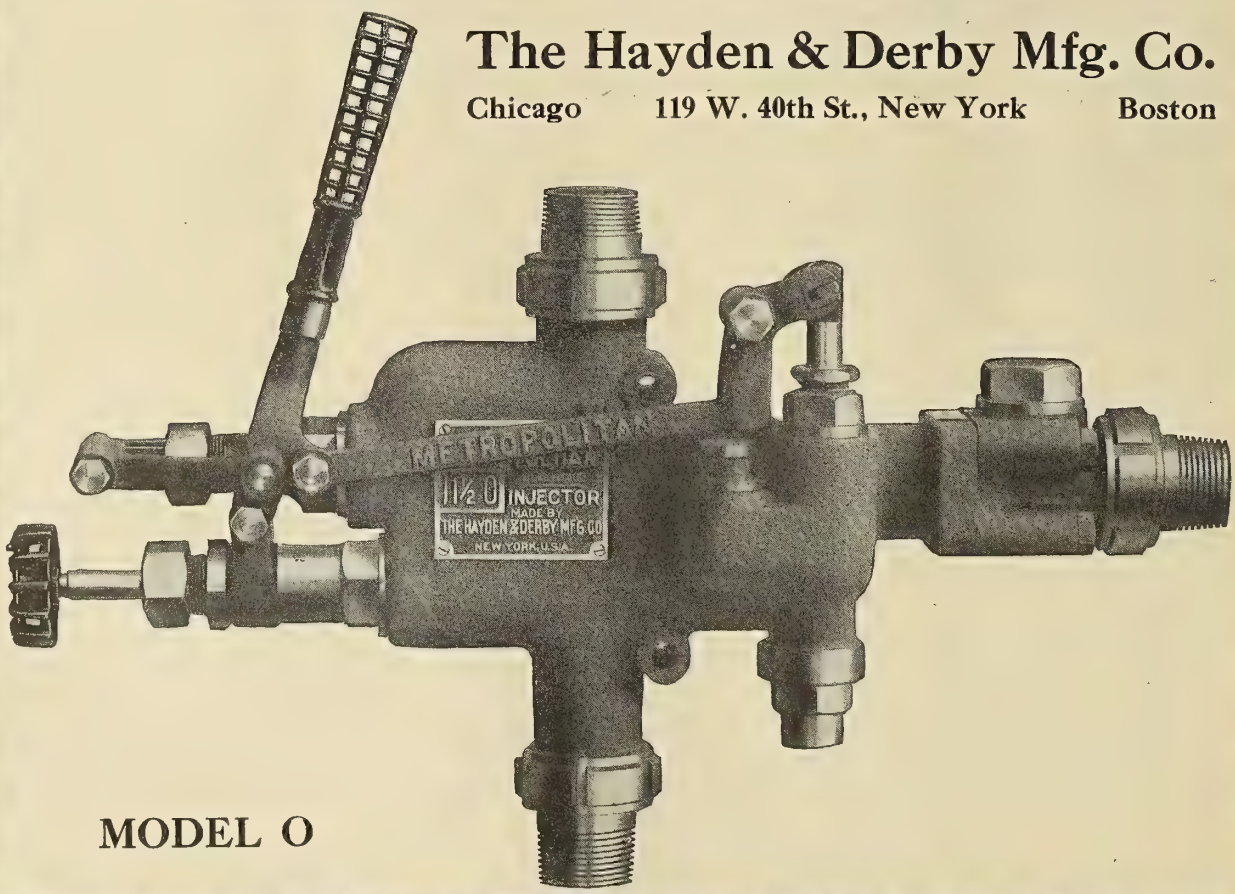
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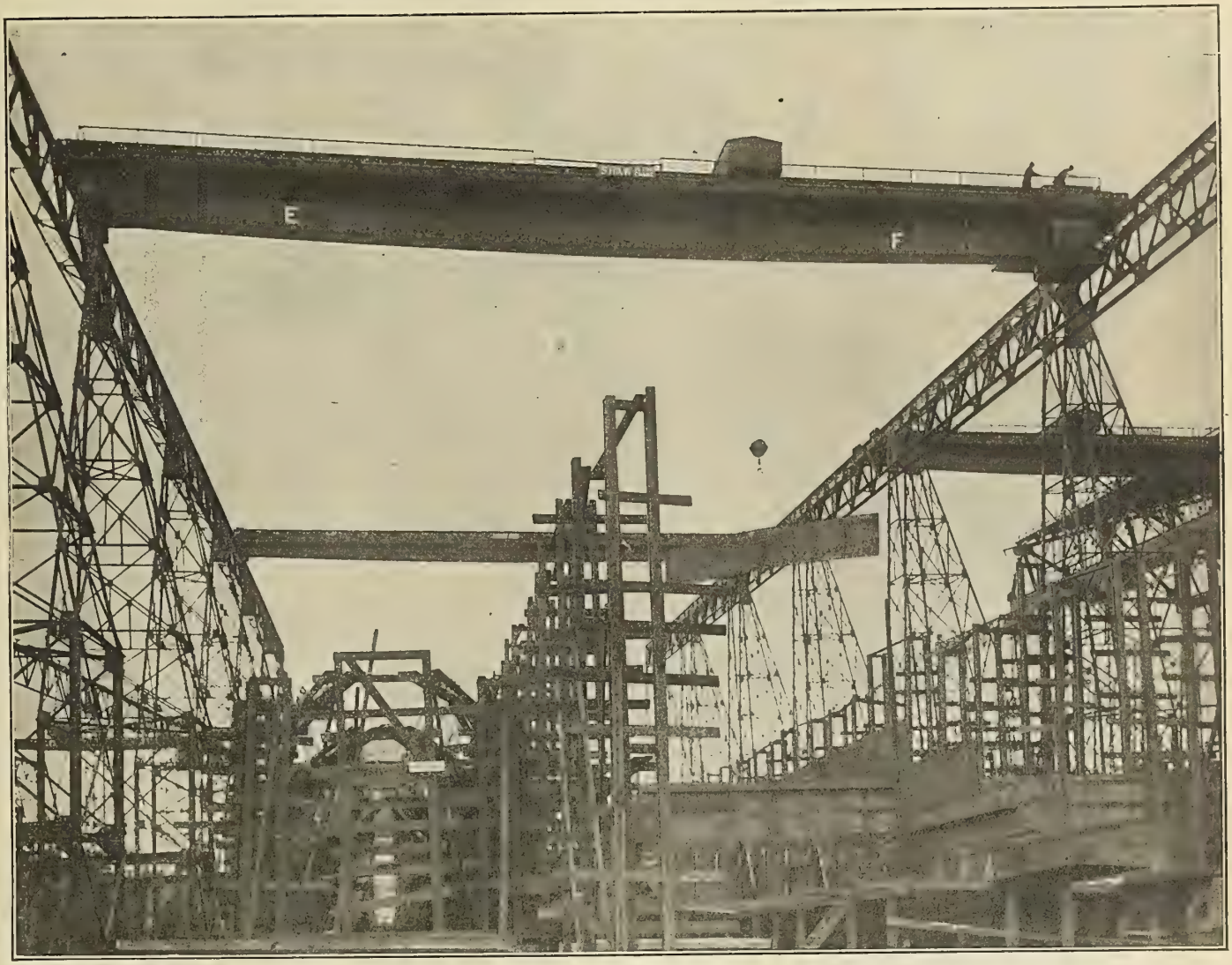
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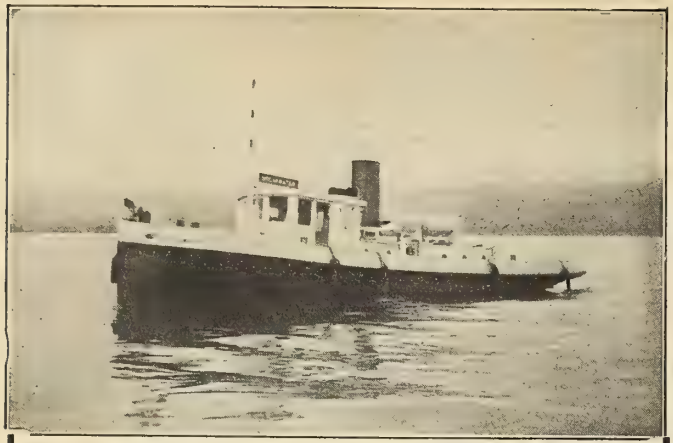
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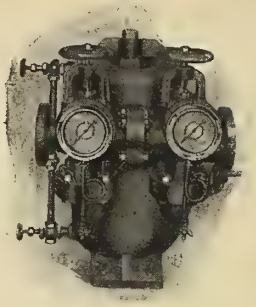
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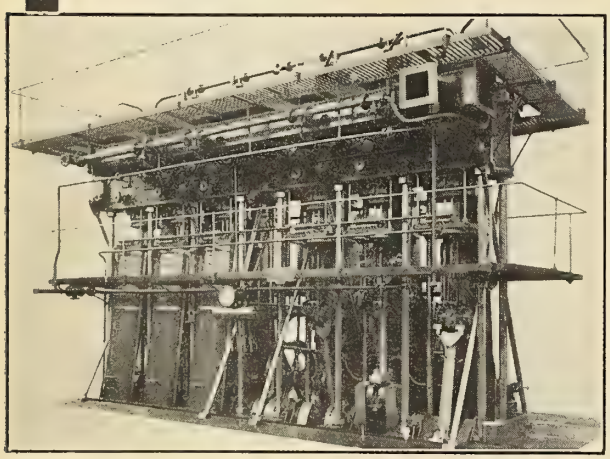
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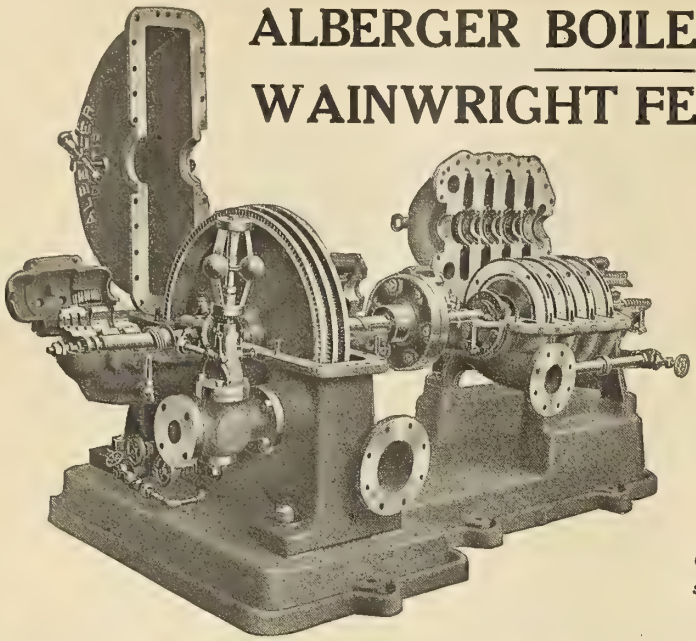
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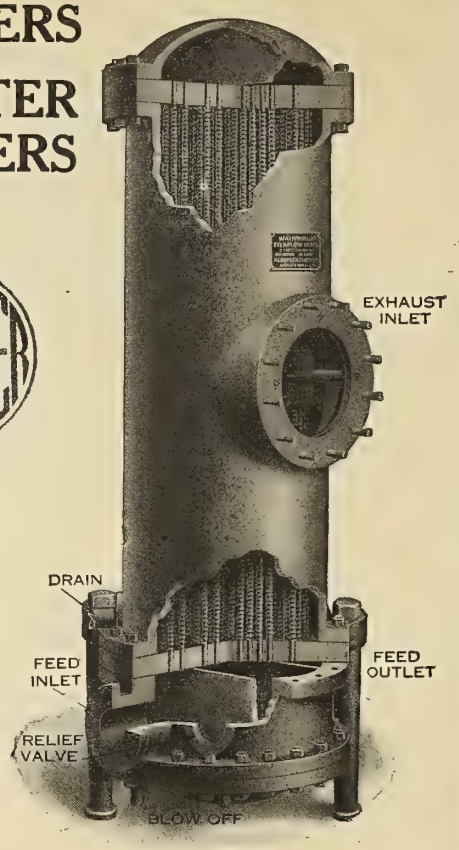
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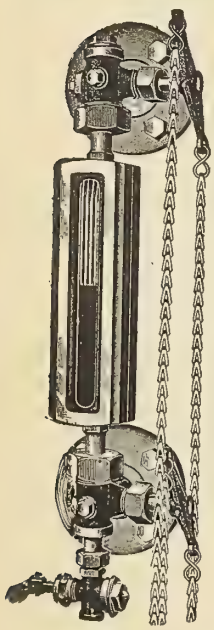
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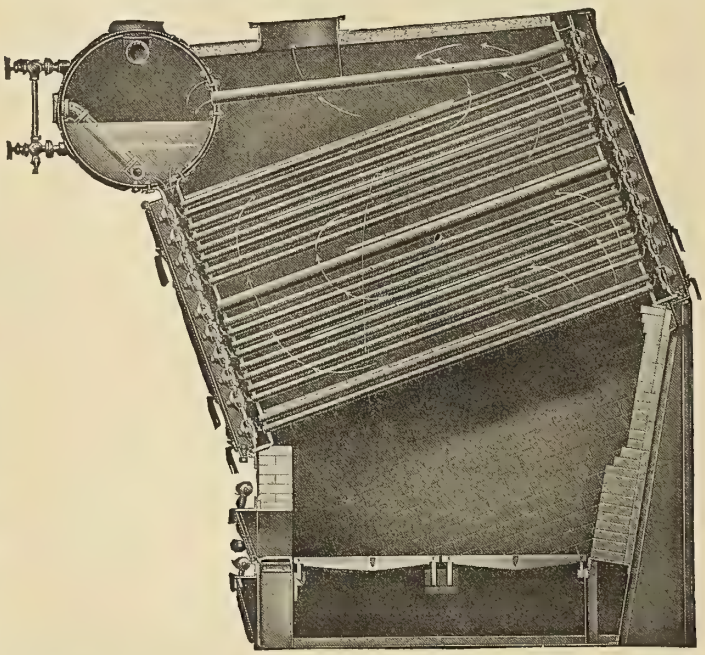
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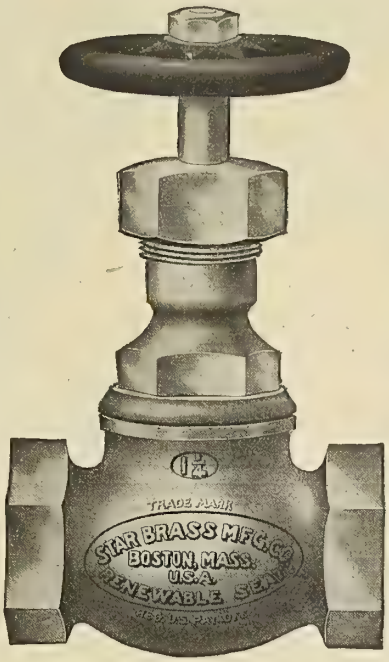
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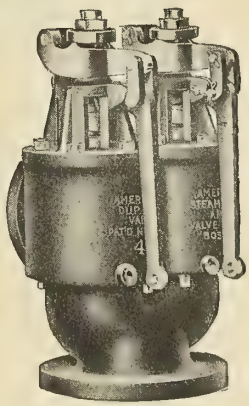
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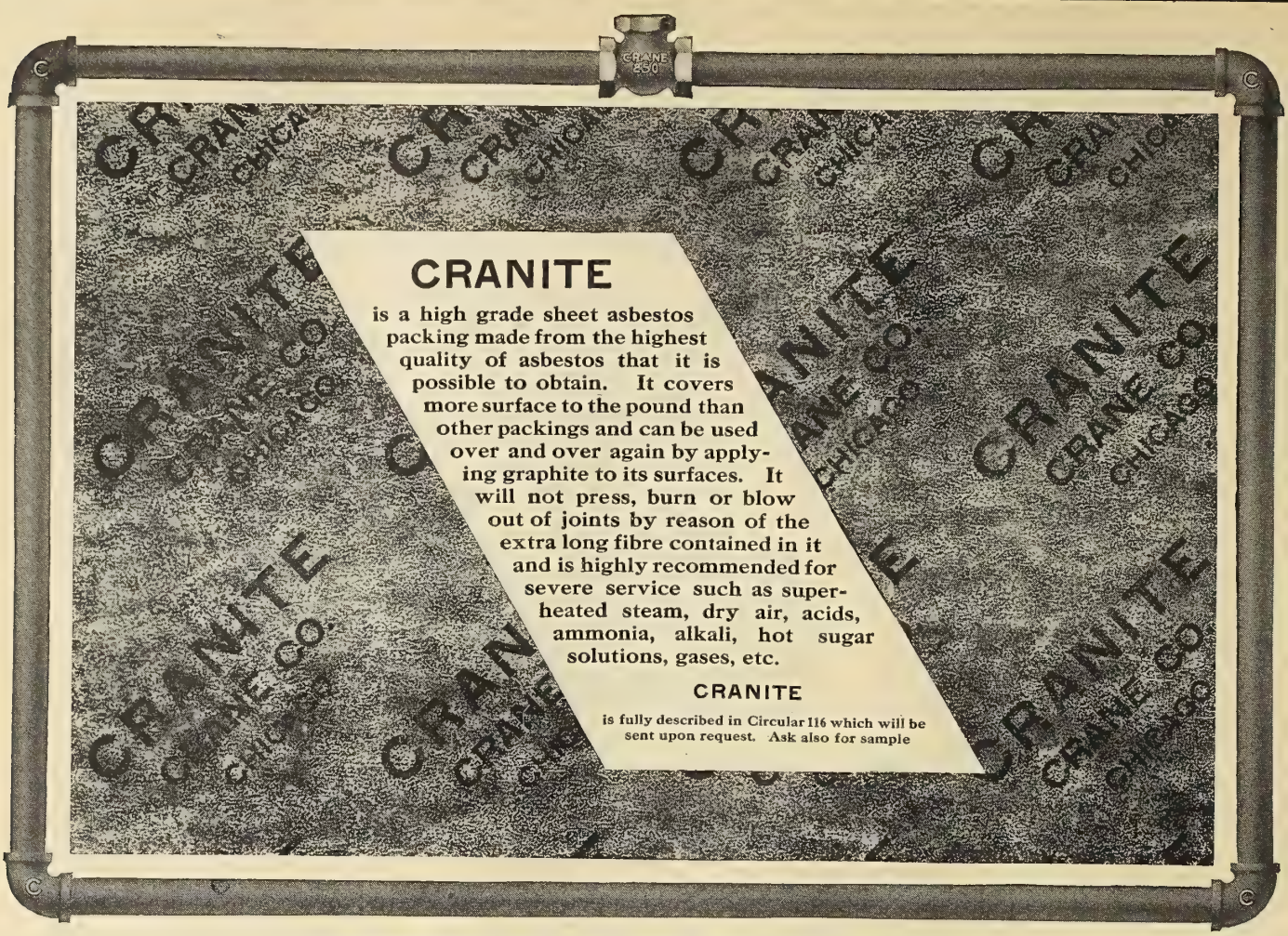
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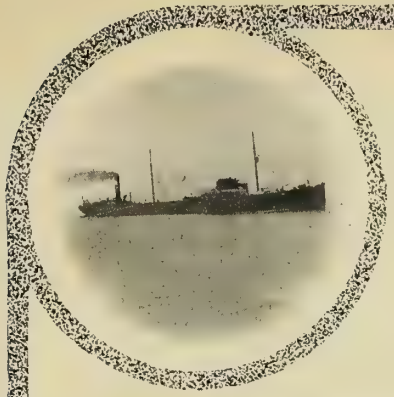
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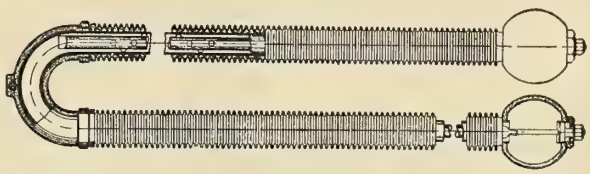
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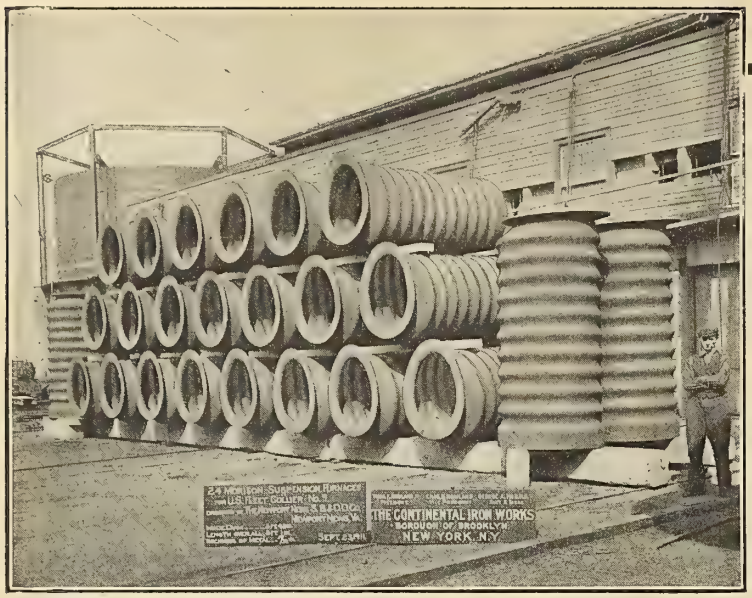


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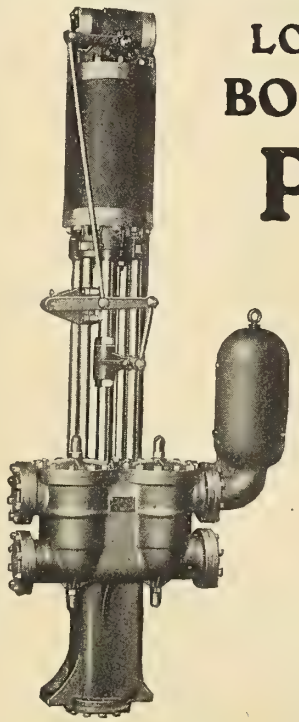
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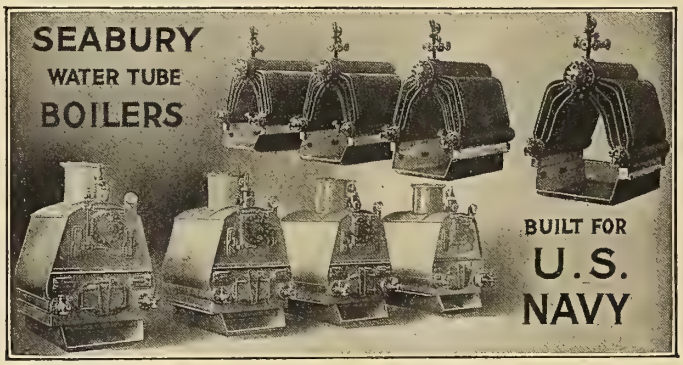
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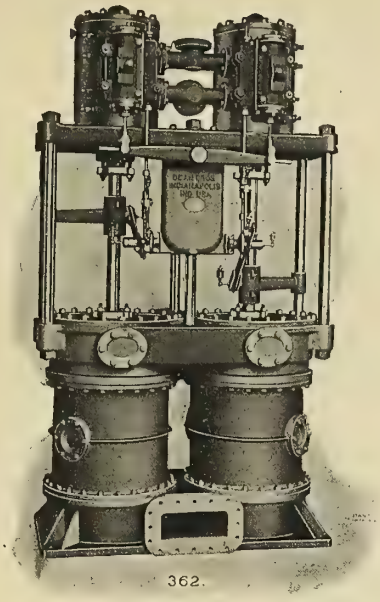
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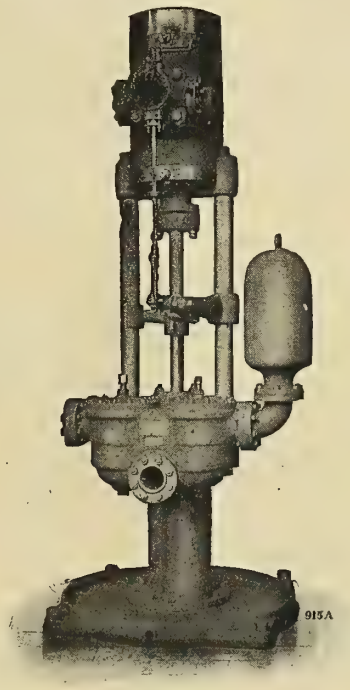
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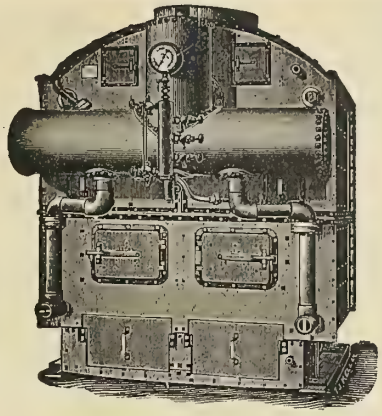
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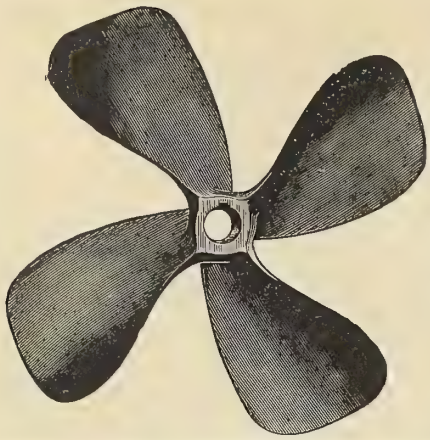
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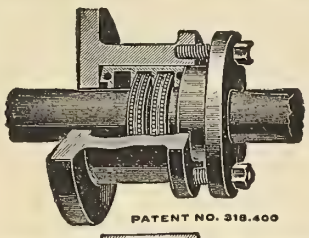
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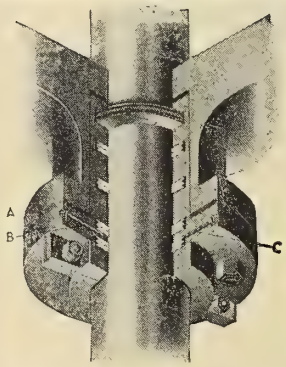
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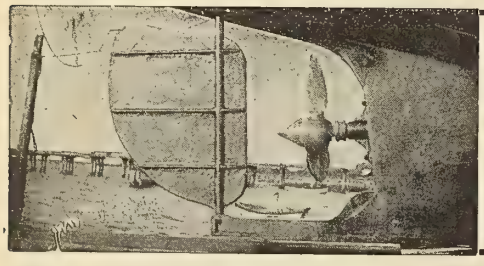
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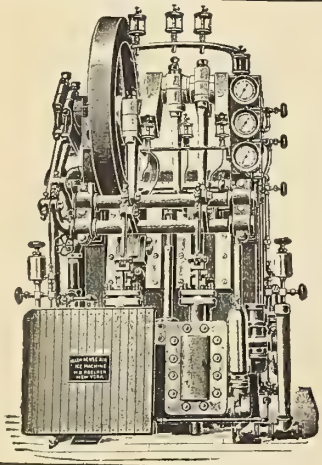
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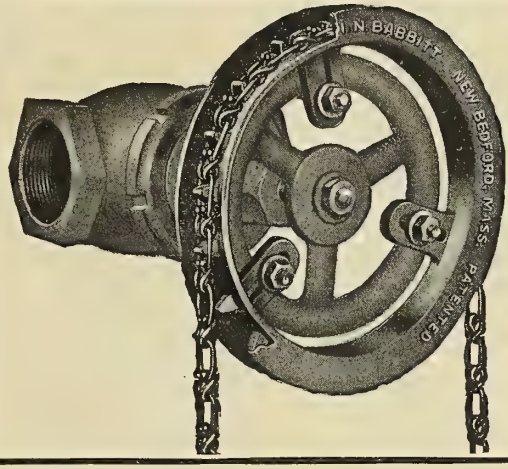
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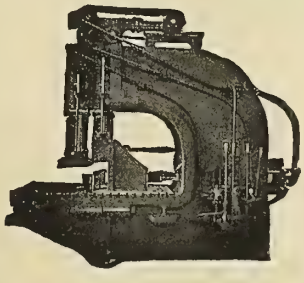
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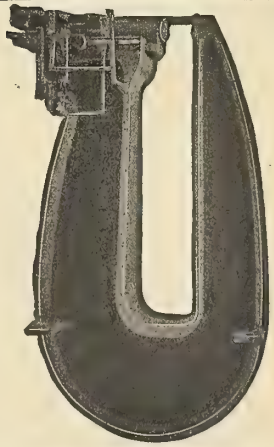
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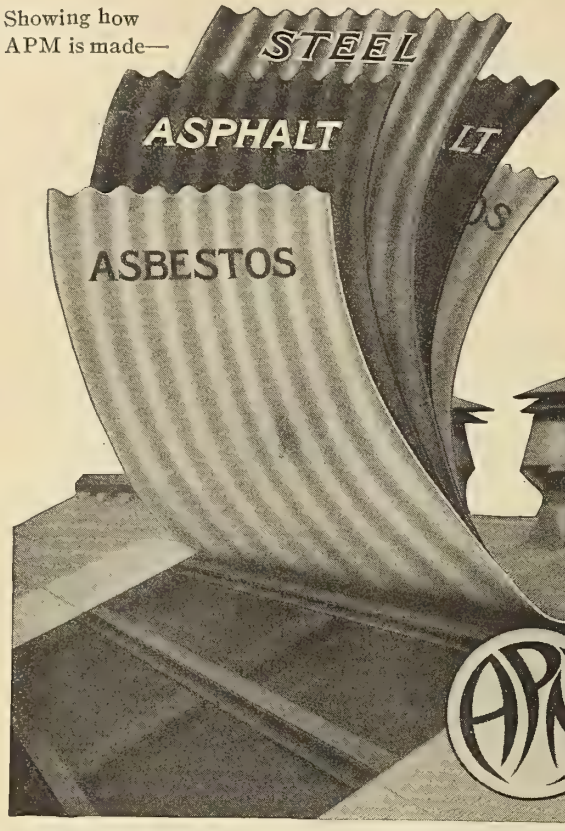
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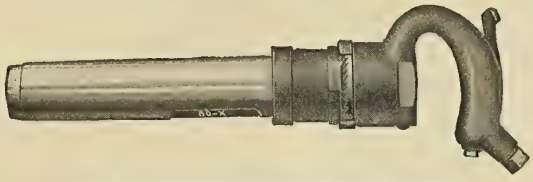
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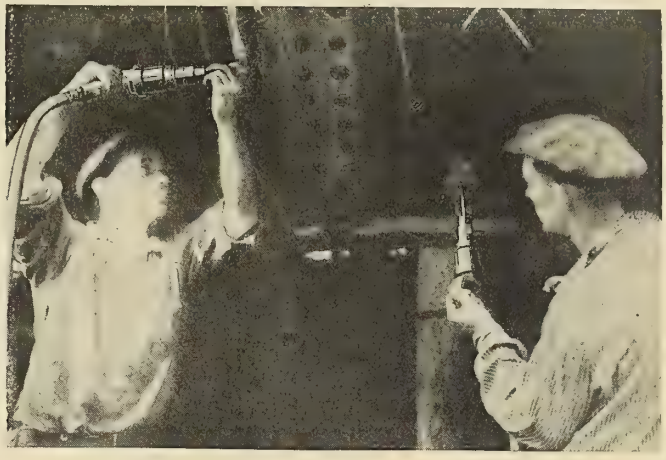
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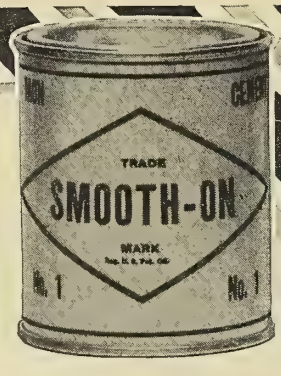
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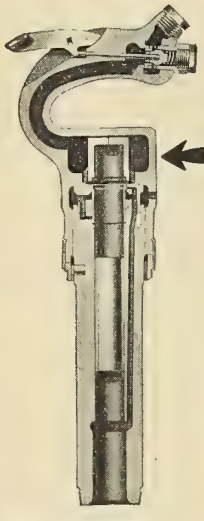
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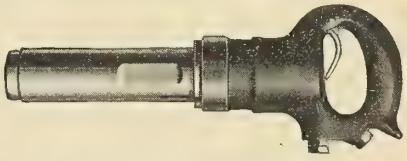


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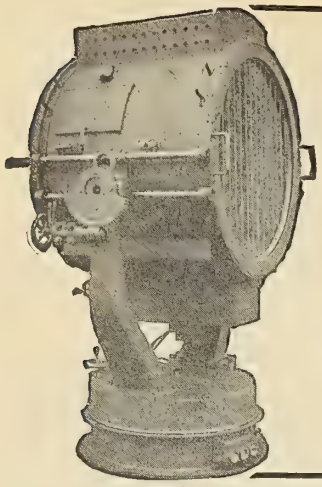


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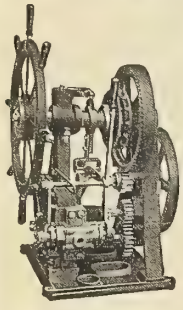


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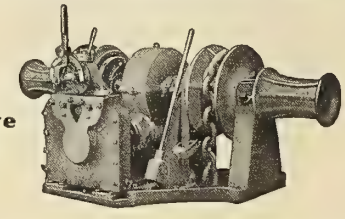
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Express Steamer Northern Pacific, built by the William Cramp & Sons, Ship and Engine Building Company, Philadelphia.

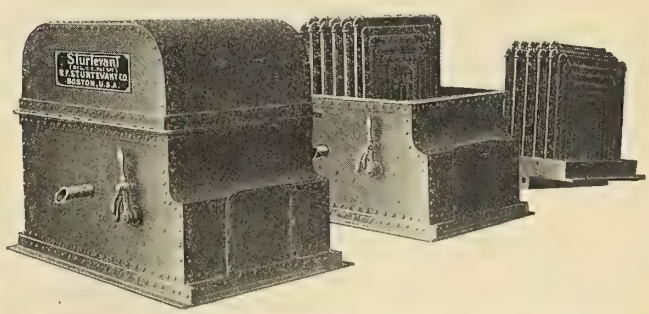
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Marine Heater

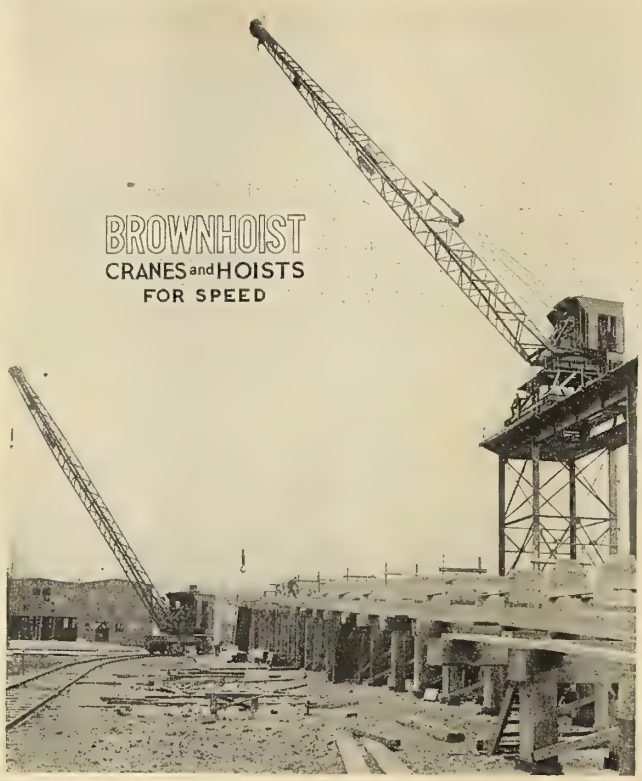
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Marine Heater such is installed on Northern Pacific. Photo shows heater with top removed, assembled heater, and heating coils with base.



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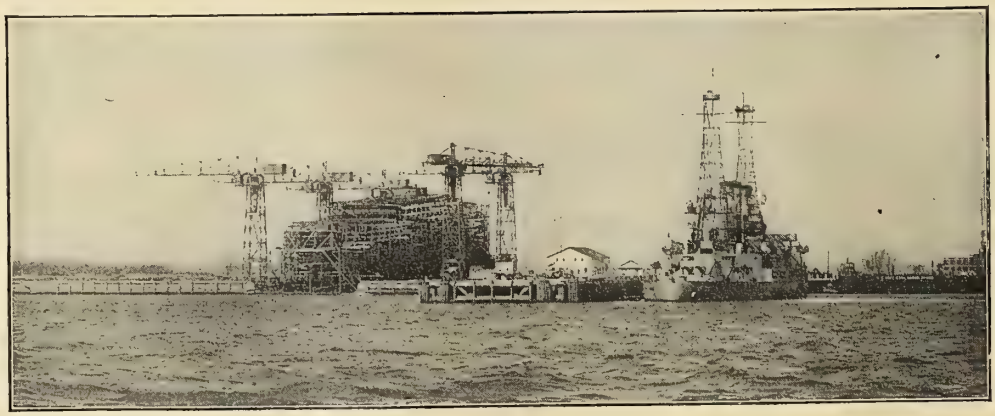
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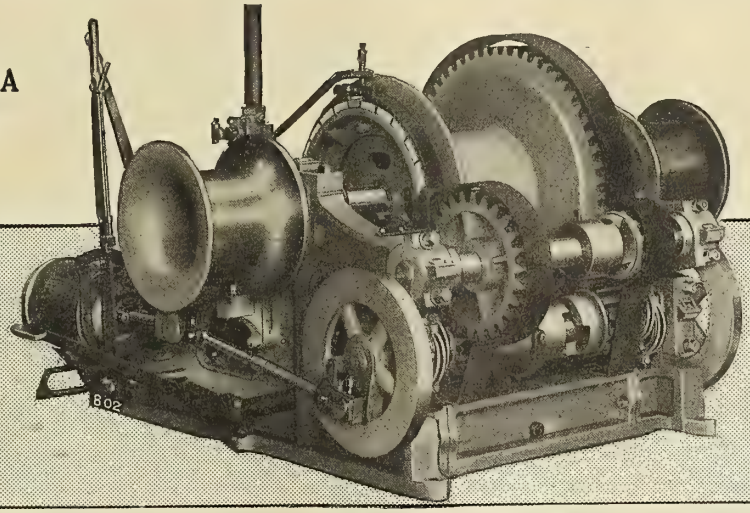
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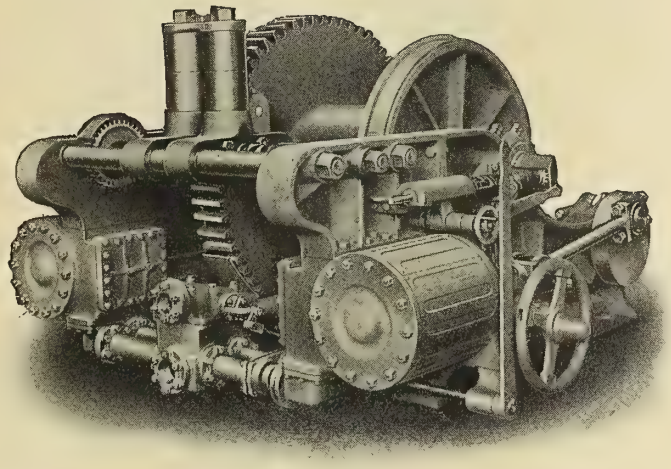
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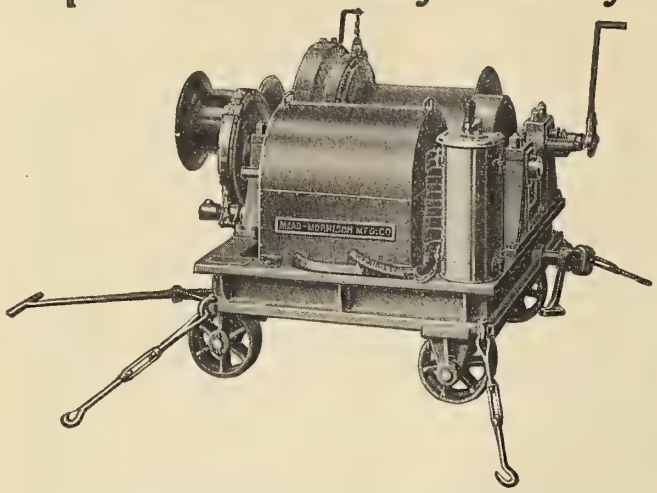
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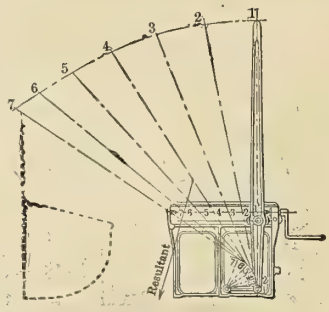
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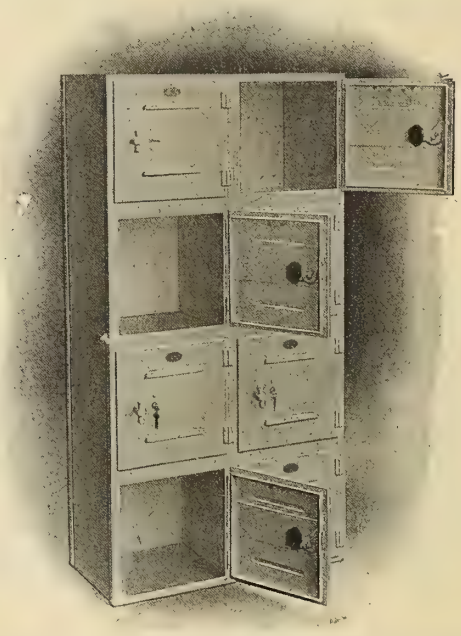
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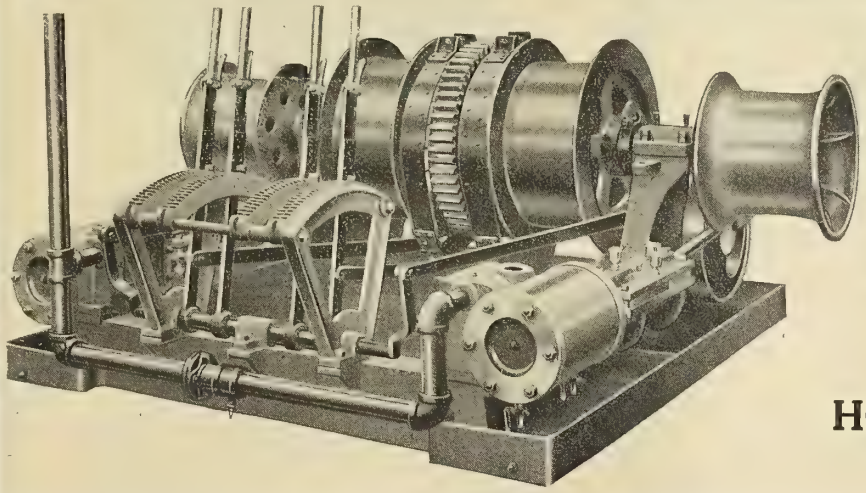
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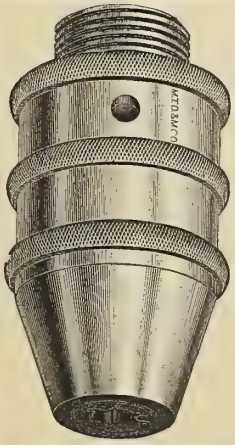
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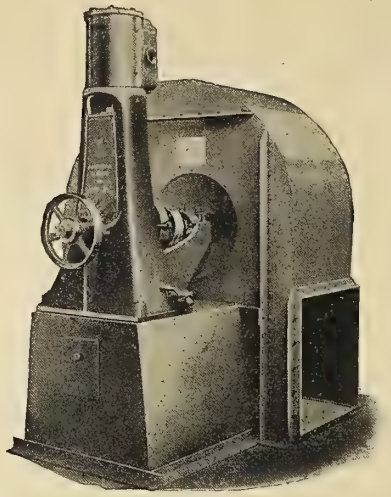
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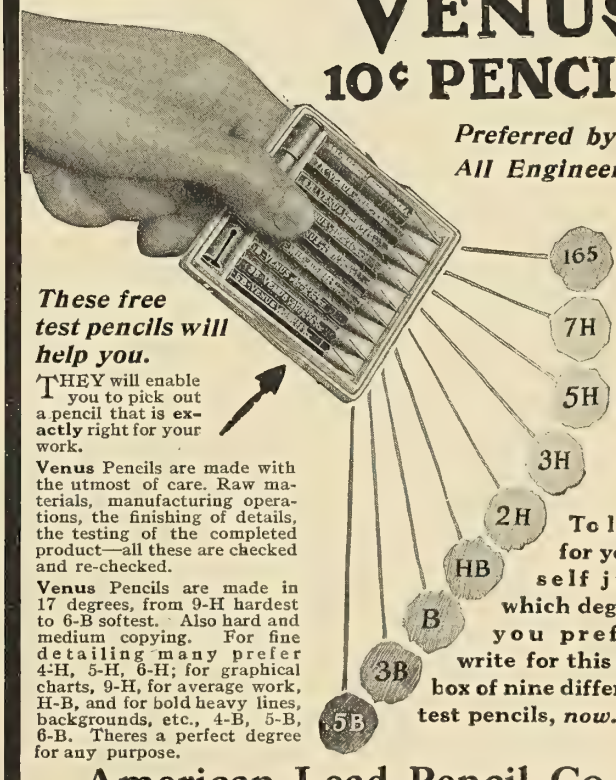
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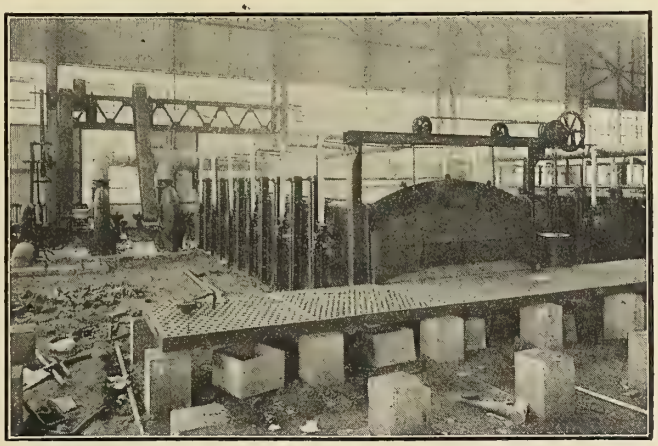


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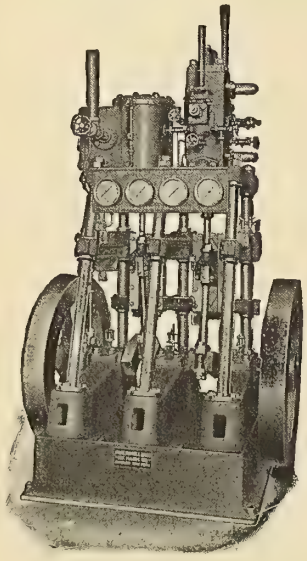
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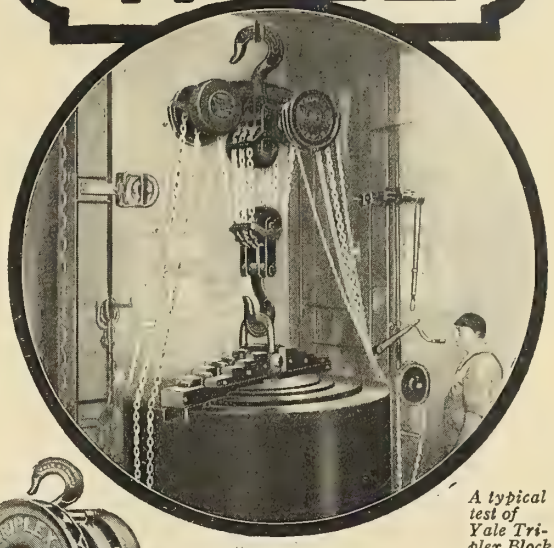
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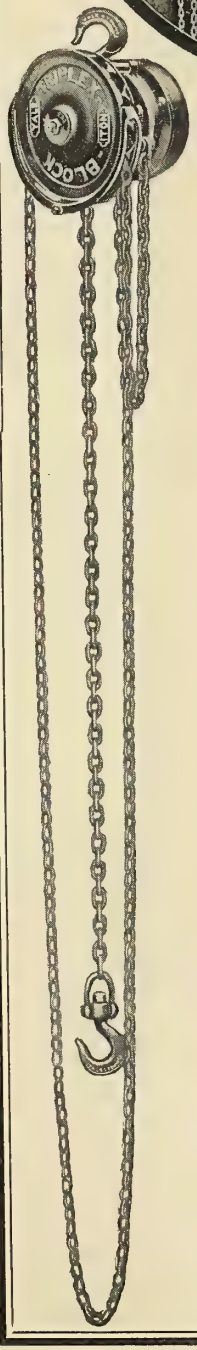
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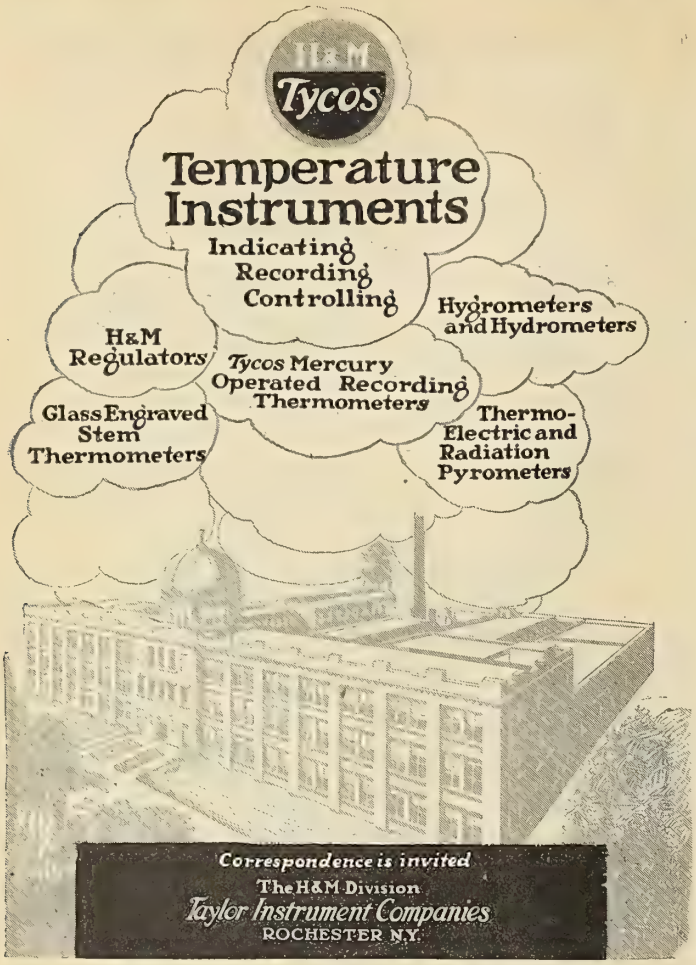
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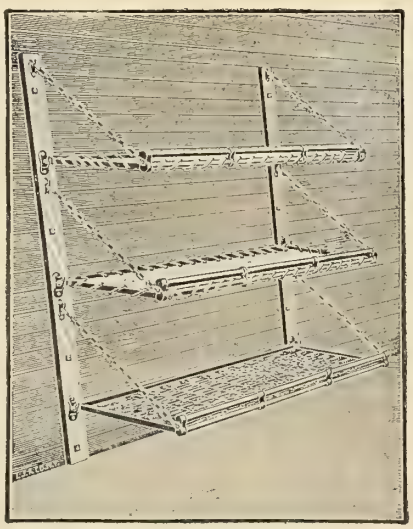
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Mietz Machine Works, August.
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Terry Steam Turbine Co.
Westinghouse Machine Co.

Engines, Gasoline.
(See Gasoline Engines.)

Engines, Hoisting.
(See Hoisting Engines.)

Engines, Kerosene.
(See Kerosene Engines.)

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(See Lubricants.)

Engines, Oil.
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Werkspoor.
Wolverine Motor Works.

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Bolinder's Company.
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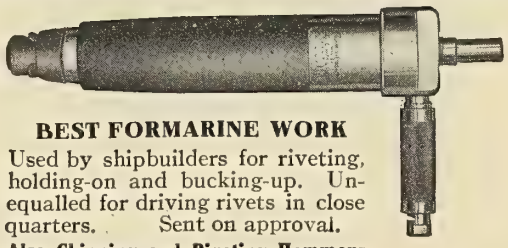
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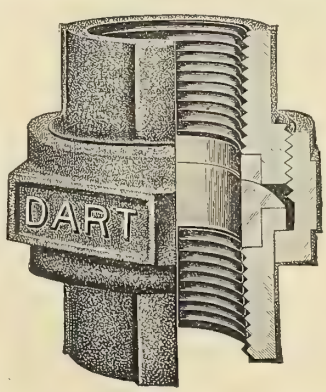
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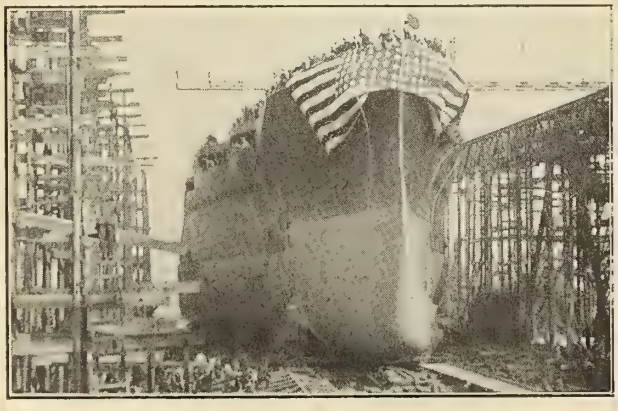
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Sands, A. B., & Son Co.
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(See Bilge Pumps.)

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(See Power Punches.)

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Punching and Shearing Machines.
Covington Machine Co.
Niles-Bement-Pond Co.

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Taylor Instrument Companies.

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(See Davits.)

Rafts.
(See Life Boats and Rafts.)

Railway Dry Docks.
Crandall Engineering Co.

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Cummings Ship Instrument Wks.
McNab Co., The.

Ranges.
Sands, A. B., & Son Co.
Williams, William E.

Rasps.
Nicholson File Co.
Wiliams, William E.

Reamers.
Morse Twist Drill & Machine Co.
Williams, William E.

Reamers.
Independent Pneumatic Tool Co.

Reducing Gears.
(See Gears.)

Reducing Valves.
(See Valves.)

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Brunswick Refrigerating Co.
Clothel Co., The.
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(See Valves.)

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(See Valves.)

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Ashton Valve Co.
McNab Co., The.
Williams, William E.

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General Electric Co.
Weston Electrical Instrument Co.

Rigging.
(See Rope; also Wire Rope.)

River Boats.
(Also see Shipbuilders.)
Fletcher, W. & A., Co.
Gas Engine & Power Co., and Chas. L. Seabury & Co., Consol.
Merrill-Stevens Co.
Moore & Sons Corp., S. L.
New London Ship & Engine Co.
Ward, Chas., Engineering Works.

Riveting Machines, Hydraulic and Steam Power.
Hanna Engineering Works.
Independent Pneumatic Tool Co.
Niles-Bement-Pond Co.

Riveters, Pneumatic.
(See Power Riveters.)

Rivets.
Carlin, Anthony.
Champion Rivet Co.

Roller Bearings.
(See Thrust Bearings.)

Rolls, Bending and Straightening.
Niles-Bement-Pond Co.

Roofing, Fireproof.
(See Fireproof Construction.)

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Dixon, Joseph, Crucible Co.
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(Also see Wire Rope and Manila and Sisal Rope.)
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Griscom-Russell Co.
Plymouth Cordage Co.
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(See Blowers.)

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(See Launches and Yachts.)

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Williams, William E.

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Griscom-Russell Co.
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Rubber Matting Cement.
Ferdinand, L. W., & Co.

Rubber Tiling.
(See Interlocking Rubber Tiling.)

Safety Devices.
(See Life Saving Devices.)

Safety Valves.
(See Valves.)

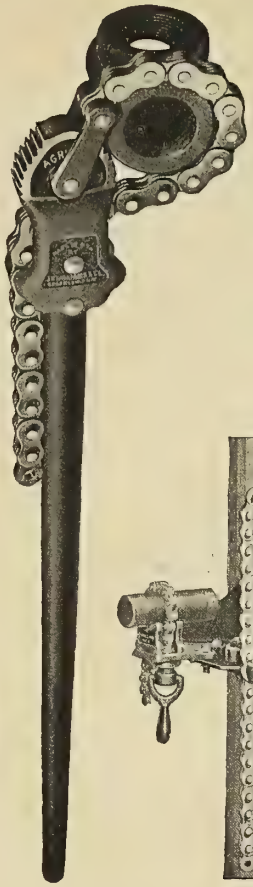
Sanitary Fittings.
(See Plumbing.)

Sanitary Pumps.
(See Plumbing.)

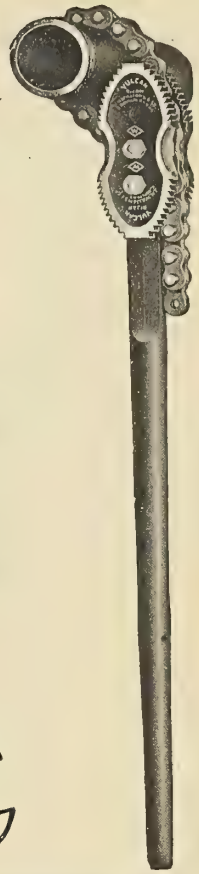
Searchlights.
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Sentinal Valves.
(See Valves.)

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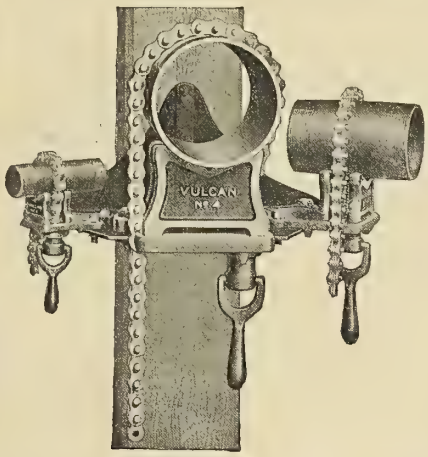
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(See Marine Glue.)

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(See Rivets.)

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(See Shipbuilders.)

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Williams Valve Co., D. T.

Steam Specialties.
Alberger Pump & Condenser Co.
American Blower Co.
American Steam Gauge & Valve Mfg. Co.
Ashcroft Mfg. Co.
Ashton Valve Co.
Consolidated Valve Co.
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Sturtevant Co., B. F.
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American Blower Co.
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Williams Valve Co., D. T.
Williams, William E.

Steam Turbines.
Alberger Pump & Condenser Co.
Bath Iron Works.
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Fletcher, W. & A., Co.
Fore River Shipbuilding Corp.
General Electric Co.
Kerr Turbine Co.
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Steam Turbine Dynamos.
De Laval Steam Turbine Co.
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Continental Iron Works, The.
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Williams, William E.

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(See Ranges.)

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(See Rolls.)

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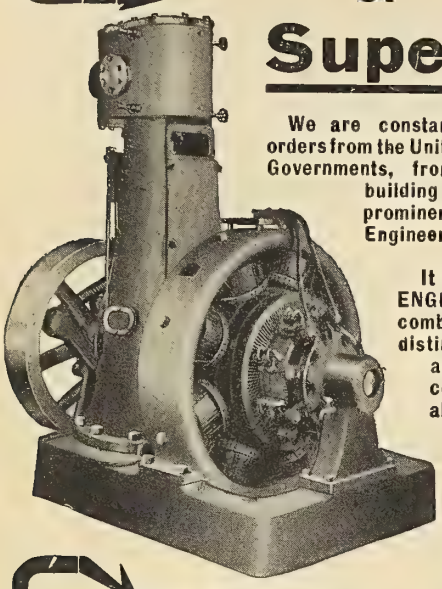
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(See Steam Traps.)

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(See Steam Turbines.)

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(See Lathes, Turret.)

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(See Boilers.)

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(See Valves, Water.)

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American Steam Gauge & Valve Mfg. Co.
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Powell Co., The, Wm.
Star Brass Mfg. Co.

White Metal.
Griscom-Russell Co.

Winches.
(See Windlasses.)

Windlasses.
American Engineering Co.
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Hyde Windlass Co.
Lidgerwood Mfg. Co.
Moore & Sons Corp., S. L.
Mundy, J. S., Hoisting Engine Co.

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American Engineering Co.
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Wrenches.
(Also see Pipe Wrenches.)
Greene, Tweed & Co.
Williams & Co., J. H.

Yacht Brokers.
(See Ship Brokers.)

Yachts.
(See Launches and Yachts.)

INDEX TO ADVERTISERS

	PAGES
Albany Lubricating Co., New York	63
Alberger Pump and Condenser Co., New York	36
Almy Water Tube Boiler Co., Providence, R. I	41
American Blower Co., Detroit, Mich	56
American Bureau of Shipping, New York	18
American Engineering Co., Philadelphia, Pa	53
American Lead Pencil Co., New York	57
American Manganese Bronze Co., Holmesburg, Pa	7
American Screw Propeller Co., Philadelphia, Pa	8
American Steam Gauge & Valve Mfg. Co., Boston, Mass	37
Asbestos Protected Metal Co., Pittsburgh, Pa	48
Ashcroft Mfg. Co., New York	
Ashton Valve Co., Boston, Mass	8
Babbitt Steam Specialty Co., New Bedford, Mass	47
Babcock & Wilcox Co., New York	37
Baldt Anchor Co., Chester, Pa	56
Baltimore Dry Docks and Shipbuilding Co., Baltimore, Md	45
Bantam Anti-Friction Co., Bantam, Conn	50
Bath Iron Works, Bath, Maine	44
Bernstein Mfg. Co., Philadelphia, Pa	54
Blake & Knowles Steam Pump Works, New York	21
Bogert, John L., New York	58
Bolinder's Company, New York	9
Bowes & Mower, Philadelphia, Pa	58
Brown, Arthur R., London, England	46
Brown Hoisting Machinery Co., Cleveland, Ohio	52
Brunswick Refrigerating Co., New Brunswick, N. J	13
Butterfield, W. P., Ltd., Yorks, England	
California Shipbuilding Co., Long Beach, California	46
Carlisle & Finch Co., Cincinnati, Ohio	50
Central Iron & Steel Co., Harrisburg, Pa	46
Chambersburg Engineering Co., Chambersburg, Pa	47
Champion Rivet Co., Cleveland, Ohio	Outside Back Cover
Chicago Pneumatic Tool Co., Chicago, Ill	49
Cleveland Pneumatic Tool Co., Cleveland, Ohio	49
Clothel Company, The, New York	42
Columbian Rope Co., Auburn and New York	Below Table of Contents, in Front of Magazine
Continental Iron Works, The, Brooklyn, N. Y	40
Coston Signal Co., New York	69
Covington Machine Co., New York	
Cox & Stevens, New York	58
Craig Engine & Machine Works, Jas., Jersey City, N. J	35
Crandall Engineering Co., East Boston, Mass	Outside Front Cover
Crane Co., Chicago, Ill	38
Crosby, Lockwood & Son, London, England	
Crowell, Chas. N., Galveston, Tex	58
Cummings Ship Instrument Works, Boston, Mass	57
Dake Engine Co., Grand Haven, Mich	50
Dart Mfg. Co., E. M., Providence, R. I	63
Davidson, M. T., Co., New York	40
Dean Bros. Steam Pump Works, Indianapolis, Ind	41
Decker, Delbert H., Millerton, N. Y	50
De Laval Steam Turbine Co., Trenton, N. J	19
Dixon Crucible Co., Jos., Jersey City, N. J	Inside Front Cover and 5
Donnelly, W. T., New York	44 and 58
Durable Wire Rope Co., Boston, Mass	56
Eckliff Automatic Boiler Circulator Co., Detroit, Mich	38
Engberg's Electric & Mechanical Works, St. Joseph, Mich	68
Eureka Fire Hose Mfg. Co., New York	10
Farley Co., Edward P., Chicago, Ill	58
Ferdinand & Co., L. W., Boston, Mass	10
Fletcher Co., W. & A., Hoboken, N. J	44
Fore River Shipbuilding Corporation, Quincy, Mass	45
France Packing Co., Philadelphia, Pa	42
Gas Engine & Power Co., and Chas. L. Seabury & Co., Consolidated, Morris Heights, N. Y	40
General Electric Co., Schenectady, N. Y	22
Goldschmidt Thermit Co., New York	55
Greene, Tweed & Co., New York	Outside Back Cover
Griscom-Russell Co., New York	34
Hancock Inspirator Co., New York	
Hanna Engineering Works, Chicago, Ill	
Hayden & Derby Mfg. Co., New York	28
Heine Safety Boiler Co., New York	51
Holmes Metallic Packing Co., Wilkesbarre, Pa	42
Holzapfels American Compositions Co., New York	8
Hough, Edward S., San Francisco, Cal	58
Hyde Windlass Co., Bath, Me	Inside Front Cover
Independent Pneumatic Tool Co., Chicago and New York	49
Isherwood, J. W., London, England	24 and 25
Jerguson Gage & Valve Co., Boston, Mass	36
Kerr Turbine Co., Wellsville, N. Y	55
Kroeschell Bros., Ice Machine Co., Chicago, Ill	60
Lane, C. M., Life Boat Co., Brooklyn, N. Y	45

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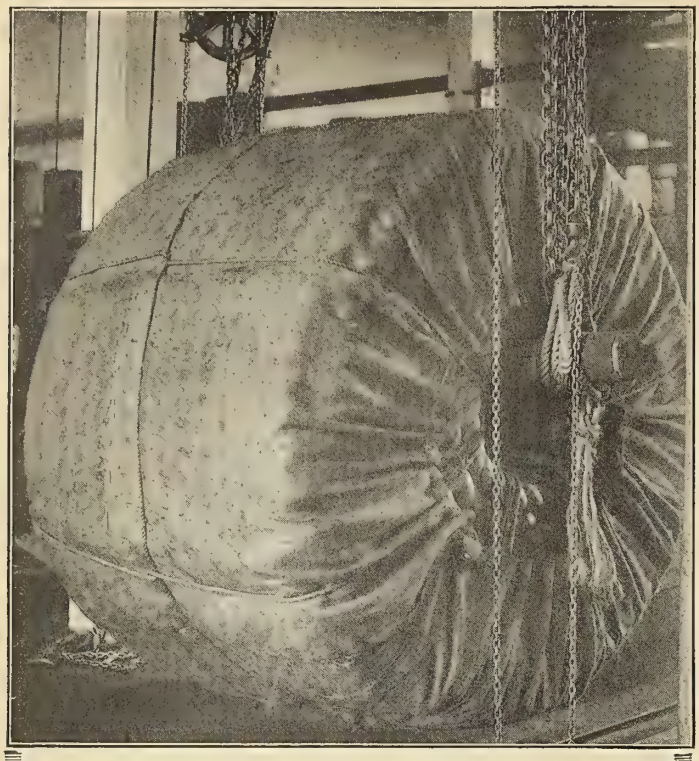
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	PAGES
Lidgerwood Mfg. Co., New York	53
Locomotive Superheater Co., New York	3
Lunkenheimer Co., The, Cincinnati, Ohio	Inside Front Cover
McMyler-Interstate Co., Cleveland, Ohio	52
McNab Co., The, Bridgeport, Conn	50
Manitowoc Ship-Building Co., Manitowoc, Wis	46
Manning, Maxwell & Moore, Inc., New York	28 and 29
Mead-Morrison Mfg. Co., East Boston, Mass	54
Merrill-Stevens Co., Jacksonville, Fla	44
Metals Production Equipment Co., New York	59
Mietz Machine Works, August, New York	23
Moore, S. L. & Sons, Corp., Elizabeth, N. J	45
Morse, Andrew J., & Son, Inc., Boston, Mass	10
Morse Twist Drill & Machine Co., New Bedford, Mass	55
Mott Iron Works, J. L., New York	65
Mundy Hoisting Engine Co., J. S., Newark, N. J	55
National Motor Boat Show, New York	10
National Tube Co., Pittsburgh, Pa	26 and 27
New London Ship & Engine Co., Groton, Conn	35
Newport News Ship Building & Dry Dock Co., Newport News, Va	45
Nicholson File Co., Providence, R. I	54
Niles-Bement Pond Co., New York	50
Norwalk Iron Works, South Norwalk, Conn	56
Oldham, Geo. & Son Co., Philadelphia, Pa	63
Parsons Marine Steam Turbine Co., New York	42
Peerless Rubber Mfg. Co., New York	12
Peninsular Shipbuilding Co., Portland, Oregon	43
Plymouth Cordage Co., North Plymouth, Mass	70
Pneumercator Co., New York	20
Pocahontas Fuel Co., New York	47
Powell, William Co., The, Cincinnati, Ohio	4
Power Specialty Co., New York	39
Quigley Furnace and Foundry Co., New York	59
Roelker, H. B., New York	46
Ross Schofield Co., New York	40
Row & Davis, Engineers, Inc., New York	39
Samson Cordage Works, Boston, Mass	68
Sands & Son Co., A. B., New York	57
Schutte & Korting Co., Philadelphia, Pa	57
Scully Steel and Iron Co., Chicago and New York	41
Seattle Construction & Dry Dock Co., Seattle, Wash	44
Shepard, George C., Baltimore, Md	58
Shepard Electric Crane & Hoist Co., Montour Falls, N. Y	Inside Back Cover
Sheriffs Mfg. Co., Milwaukee, Wis	42
Shipley Construction and Supply Co., Brooklyn, N. Y	17
Smooth-On Mfg. Co., Jersey City, N. J	49
Southern-Rome, The, Baltimore, Md	62
Southwark Foundry & Machine Co., Philadelphia, Pa	8
Sprague Electric Works, New York	54
Standard Motor Construction Co., Jersey City, N. J	34
Star Brass Mfg. Co., Boston, Mass	37
Starrett, L. S., Co., Athol, Mass	7
Steward Davit & Equipment Corp., New York	54
Sturtevant Co., B. F., Hyde Park, Mass	51
Sun Shipbuilding Co., Philadelphia, Pa	15
Talbot Boiler Co., New York	16
Tank-Ship Building Corp., New York	45
Taylor Instrument Companies, Rochester, N. Y	62
Terry Steam Turbine Co., Hartford, Conn	Facing Leading Article
Tietjen & Lang Dry Dock Co., Hoboken, N. J	44
Toch Brothers, New York	66
Trout, H. G., Co., Buffalo, N. Y	42
Union Dry Dock and Repair Co., Weehawken, N. J	10
United States Metallic Packing Co., Philadelphia, Pa	42
Universal Safety Mattress Co., New York	42
Valk & Murdoch Co., Charleston, S. C	44
Vulcan Engineering Sales Co., Chicago, Ill	
Ward, Chas., Engineering Works, Charleston, W. Va	36
Waterbury Co., New York	64
Watts, J. Murray, Philadelphia, Pa	58
Weimer Chain & Iron Co., Lebanon, Pa	63
Welin Marine Equipment Co., Long Island City, N. Y	6
Werkspoor, Amsterdam, Holland	34
Westinghouse Machine Co., East Pittsburgh, Pa	30 and 31
Weston Electrical Instrument Co., Waverly Park, Newark, N. J	65
Wheeler Shipbuilding Co., Huntington, N. Y	10
Whitlock Cordage Co., New York	69
Whittelsey & Whittelsey, New York	48
Williams & Co., J. H., Brooklyn, N. Y	67
Willliams Valve Co., D. T., Cincinnati, Ohio	60
Williams, Wm. E., New York	14
Wolverine Motor Works, Bridgeport, Conn	5
Worthington Pump and Machinery Corp., New York	21
Yale & Towne Mfg. Co., New York	61
Yarrow & Co., Ltd., Glasgow, Scotland	43
Young, Rakestraw & Ferguson, Wilmington, Del	58

INTERNATIONAL
MARINE ENGINEERING

DECEMBER, 1916

CONTENTS

		PAGE
EDITORIAL COMMENT		519
MILLIONS OF DOLLARS WASTED AT MARINE TERMINALS		520
SCOPE OF AMERICAN BUREAU OF SHIPPING WIDENED BY ACQUISITION OF GREAT LAKES REGISTER AND AFFILIATION WITH BRITISH CORPORATION		520
LLOYD'S ANNUAL REPORT		521
WORLD-WIDE DEMAND FOR AMERICAN SHIPS	STEVENSON TAYLOR	523
DIESEL-ENGINED YACHT GEORGIANA III. Illustrated		527
RULES FOR ORDERING RIVETS	WILLIAM M. KENNEDY	529
NOTES FROM THE MODEL BASIN. Illustrated	Naval Constructor WILLIAM McENTEE, U. S. N.	530
MOORE AND SCOTT SHIPYARD. Illustrated		533
ALQUIST GEARING FOR SHIP PROPULSION. Illustrated	W. L. R. EMMET	536
PENINSULA SHIPBUILDING COMPANY. Illustrated		538
NAVAL ARCHITECTS' ANNUAL MEETING		539
NEW BOOKS FOR MARINE ENGINEERS		550
LETTERS FROM MARINE ENGINEERS:		
ECONOMICAL REPAIR TO WORN PLUNGER IN MAIN AIR PUMP. Illustrated		551
SOME ECONOMY KINKS. Illustrated		551
STOP VALVES		553
SETTING AND CARE OF SPRING LOADED SAFETY VALVES		554
A POOR COMBINATION		554
QUESTIONS AND ANSWERS FOR MARINE ENGINEERS. Illustrated	H. A. EVERETT	555
SHIPBUILDING AND GENERAL MARINE NEWS. Illustrated		557
PERSONAL		559
SELECTED MARINE PATENTS. Illustrated		560

LONDON
CHRISTOPHER STREET
FINSBURY SQUARE, E. C.

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NEW YORK
PRINTING CRAFTS BLDG.
461 EIGHTH AVENUE

Notice to Advertisers.—Changes to be made in copy, or in orders for advertising, must be in our hands not later than the 18th of the month, to insure the carrying out of such instructions in the issue of the month following. If proof is to be submitted, copy must be in our hands not later than the 15th of the month.

This magazine is member No. 448 of the Audit Bureau of Circulations.

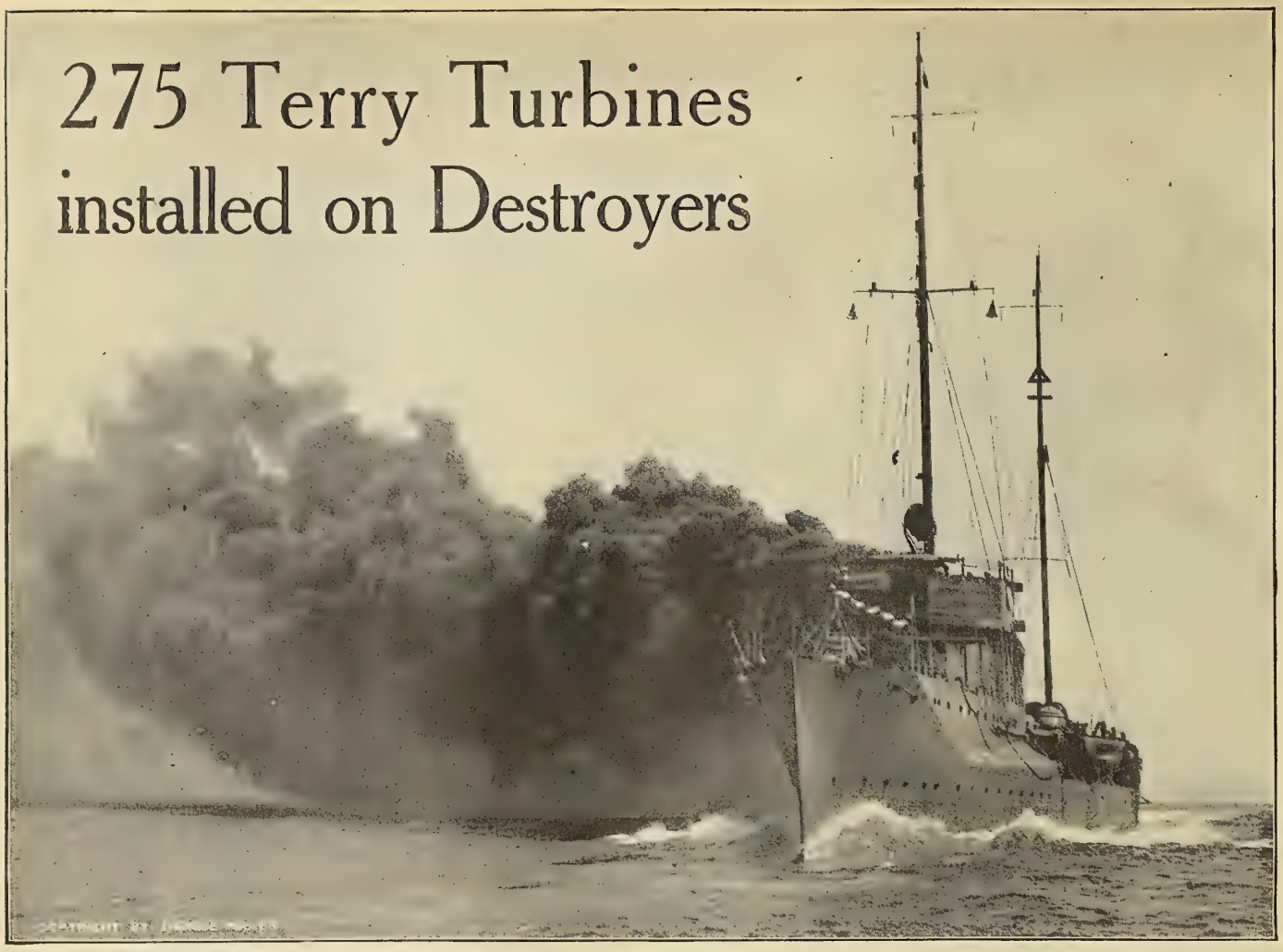
3,900 *copies of this issue were printed.*

MARINE ENGINEERING may be purchased at the following News Stands:

EASTERN HOTEL NEWS STAND, Whitehall and South Streets, New York
WHITEHALL BUILDING, 17 Battery Place, New York
PRODUCE EXCHANGE, Beaver Street, New York
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275 Terry Turbines installed on Destroyers



SIMPLE construction, reliable operation, and high efficiency at low speeds are all qualities that are highly desirable in auxiliary turbines on shipboard.

The first turbines in which these qualities were combined were manufactured under the Terry patents, the validity of which has recently been sustained by the Court of Appeals.

Because these qualities could be found in no other turbine, the drive selected for destroyer blowers by the U. S. Navy has almost invariably been

THE TERRY TURBINE

IN ADDITION to about 150 Terrys used on U. S. Destroyers there are about as many more used on U. S. Battleships, and a large number in foreign navies.

Terry Turbines are specially desirable for driving generators, blowers and pumps. Our nearest office will gladly give further information.

The Terry Steam Turbine Co.

Main Office and Works, HARTFORD, CONNECTICUT

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T-355

INTERNATIONAL MARINE ENGINEERING

Main Office: NEW YORK, 17 Battery Place SUBSCRIPTION PRICE: Domestic, $2.00; Foreign, $2.50 LONDON OFFICE: 31 Christopher St., E. C.

Asbestos Protected Metal

for Roofing and Siding





IT IS as light as sheet steel, but is PERMANENT. It is low in first cost and involves no maintenance or depreciation charges. It is rust-proof and fire-resisting, and does not need paint.

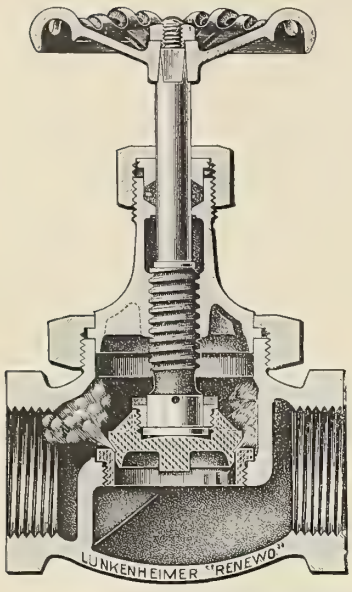
It is Steel + Asphalt + Asbestos

Steel is light, but strong. Asphalt entirely envelopes the steel and preserves it against rust and corrosion. The outer layer of hardened, water-proofed Asbestos in turn protects the Asphalt from heat and light, elements which quickly destroy its usefulness.

Bulletin 5512 describes and illustrates the application of A P M on piers, docks, warehouses and other buildings where the conditions of service are severe. Ask for a copy.

Asbestos Protected Metal Company
Pittsburgh

LUNKENHEIMER



"Renewo" Valves

"The economical Valves for severe service"

The uninterrupted service these valves give, recommends their installation, particularly where severe operating conditions exist.

All parts are renewable, and this includes the **nickel-seat ring** and **disc.**

Seating surfaces are regrindable.

Lunkenheimer "Seat-guard,"—the tubular extension on the bottom of the disc, materially aids in preserving the seating faces and keeping them clean. Passages through the bodies are full and unobstructed, the smallest area being in excess of that of the nominal diameter of the connecting pipe.

Materials used are the highest grade. Workmanship is Lunkenheimer "Quality."

Lunkenheimer "Renewo" Valves are made in sizes ¼ to 3 inches inclusive (Inside Screw), and sizes 1½ to 3 inches inclusive (Outside Screw and Yoke), in two patterns—Medium for 200 pounds and Extra Heavy for 300 pounds working steam pressure.

"BUY THE BEST—THEY ARE THE CHEAPEST."

Ask your dealer for booklet No. 535, or for Red Book No. 50.

THE LUNKENHEIMER CO.

"QUALITY"

Largest Manufacturers of High Grade Engineering Specialties in the World.

NEW YORK CHICAGO **CINCINNATI** BOSTON LONDON

Awarded ***Medal of Honor*** *Panama-Pacific International Exposition and* ***Grand Prize*** *Panama-California Exposition.*

1-6-25

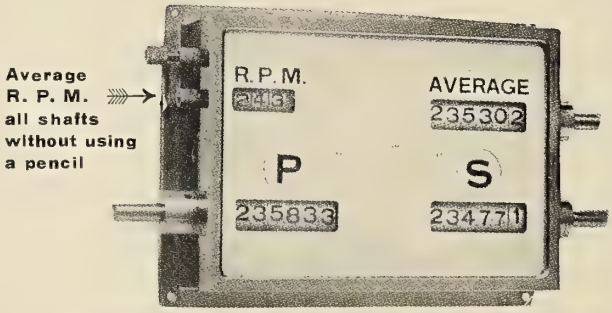
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CUMMINGS TWO-SHAFT AVERAGING COUNTER

Ideal Counter for Turbine Engines

Made for ships with 3 and 4 shafts also

Installed in more than 100 ships

Dimensions $11\,^{3}/_{4}'' \times 8\,^{3}/_{4}'' \times 3\,^{7}/_{16}''$

Weight . . . . . 23 lbs.

Send for our pamphlet on the Cummings Engine Log System or the Gary-Cummings Torsion Meter.

Cummings Ship Instrument Works

110 High Street, Boston, U. S. A.

International Marine Engineering

JANUARY, 1916

CONTENTS

		PAGE
EDITORIAL COMMENT		1
THE GEARED TURBINE AND THE TURBO-ELECTRIC SYSTEMS OF MARINE PROPULSION. Illustrated	JOHN H. MACALPINE.	4
COASTWISE COLLIER JONANCY. Illustrated		9
THE DRAFTING ROOM. Illustrated	H. C. ROBINSON	11
ELECTRIC PROPULSION OF A MERCHANT VESSEL. Illustrated		13
COAL HANDLING PLANT AT CONNEAUT DOCK. Illustrated		15
THE WERKSPOOR MARINE DIESEL ENGINE. Illustrated	J. RENDELL WILSON	16
MOTOR TRUCKS AS THE SOLUTION OF THE MARINE FREIGHT TERMINAL PROBLEM. Illustrated	MERRILL C. HORINE	20
SHIPBUILDING IN THE UNITED STATES		23
THE RE-FLOATING OF THE HENDONHALL. Illustrated	ROBERT G. SKERRETT	26
MODERN SUBMARINES IN WAR AND PEACE.—VII. Illustrated	SIMON LAKE	29
LETTERS FROM MARINE ENGINEERS:		
A MARINE ENGINEER'S KIT OF TOOLS		31
REPAIRS TO A DEFECTIVE TUBE		31
THE PRESERVATION OF MARINE BOILERS		32
QUESTIONS AND ANSWERS FOR MARINE ENGINEERS. Illustrated		35
MARINE ARTICLES IN THE ENGINEERING PRESS		37
SHIPBUILDING AND GENERAL MARINE NEWS. Illustrated		39
ENGINEERING SPECIALTIES. Illustrated		44
PERSONAL		47
SELECTED MARINE PATENTS. Illustrated		48

LONDON
CHRISTOPHER STREET
FINSBURY SQUARE, E. C.

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NEW YORK
WHITEHALL BUILDING
17 BATTERY PLACE

Notice to Advertisers.—Changes to be made in copy, or in orders for advertising, must be in our hands not later than the 20th of the month, to insure the carrying out of such instructions in the issue of the month following. If proof is to be submitted, copy must be in our hands not later than the 15th of the month.

INTERNATIONAL MARINE ENGINEERING *is member No. 448 of the Audit Bureau of Circulations.*

3,900 copies of this issue were printed.

When you want really good rope—ask for

COLUMBIAN PURE MANILA

Better get it while in port

COLUMBIAN ROPE CO., - AUBURN, N. Y.

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CHICAGO
370 River St.

BOSTON
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COLUMBIAN PURE MANILA

WHAT'S A TURBINE?

What's a turbine engine? It is what it is, is it not? But are you aware that there is as much difference in turbine engines as there is in reciprocating engines? And reciprocating engines have served mankind faithfully for years—as the horse did before the era of automobiles. The horse is now in the discard, and the reciprocating engine is getting there; that is, some of them, for many can't forget the old love. Nevertheless, the turbine is coming to the front faster each year; simply—it has a mission to perform in the new era of manufacturing. Efficiency is what counts to-day, and machinery is getting to be just as important as the mental efficiency that makes mankind move forward a peg in the march of progress.

Again let us ask the question: "What's a turbine engine?" And having asked the question, let us ask how many up-to-date owners and plant managers can give an off-hand answer that will explain the principle of such a steam engine? Precious few. Yet it is one of the engines of the near future from which the power will flow that brings the dividends to the stockholders in all of our manufacturing plants. All managers are after dividends, but not all take advantage of everything that helps to bring them about, outside of their knowledge of men and manufacturing machinery. Yet for lack of the proper power plant equipment millions of dollars are wasted into smoke and steam that could readily be turned into the dividend account. Only recently we heard of a case where an engineer who knew his business made a saving of 20 per cent, in his coal pile through convincing the manager that he ought to provide certain improvements to save money. Outside of that, an inefficient engine is just as bad practice as an inefficient man. You can easily replace an inefficient man, but it costs money to replace an inefficient engine. Just as surely as the automobile is an improvement on horse locomotion, so is the steam turbine an improvement on the reciprocating engine. And if you know nothing about turbines and their value to turn the wheels of your machinery, then get busy and send for the booklet of the Terry Steam Turbine Co. of Hartford, Conn. It will tell you more in five minutes about turbines than you have probably known in five years, unless you are up-to-date and coming.

Be up to the minute, get the knowledge that is free and learn besides what a Terry turbine engine really is. It's your duty, pure and simple, knowledge is power, and power comes from knowledge. Get the power, through a Terry turbine and the booklet of practical information they give you for the asking.

The Terry Steam Turbine Co.

HARTFORD, CONN.

Atlanta, Boston, Birmingham, Charlotte, Chicago, Cleveland, Dallas, Dayton, Denver, Grand Rapids, Houston, Lynchburg, Memphis, New York, New Orleans, Philadelphia, Pittsburgh, San Antonio, San Francisco, St. Louis, Seattle, St. Paul, Montreal, Toronto, Havana, Cuba, London, England, Johannesburg, So. Africa, Melbourne, Australia

T328

TRADE PUBLICATIONS

The "White Star" valve is the subject of a 20-page book just issued by the William Powell Company, Cincinnati, Ohio. This booklet discusses the function of the "White Star" valve and illustrates in section the several types made by the William Powell Company. The booklet also contains full information as to construction, operation and prices. Copies will be sent free to any of our readers upon request.

A metallic power lifeboat is illustrated in a circular just published by the C. M. Lane Lifeboat Company, 246 Huron street, Brooklyn, N. Y. This lifeboat is described as follows: "This boat was built by the C. M. Lane Lifeboat Company from approved specifications of the Board of Supervising Inspectors. A 12-16 horsepower Frisbie valve-in-head motor drives this boat eight miles per hour, carrying the required number of passengers, and without noticeable vibration. Independent air tanks, securely installed, will float the boat, engine and passengers when intermittingly submerged. For quality and efficiency specify the C. M. Lane Lifeboat Company's metallic lifeboats, their pontoon lifeboats, pontoon life rafts and power lifeboats, approved to pass the latest rules and regulations of the United States Board of Supervising Inspectors."

Asbestos protected metal for use on steamship docks, piers and warehouses is described in Bulletin 55 just published by the Asbestos Protected Metal Company, First National Bank Building, Pittsburg, Pa. Among the illustrations in this bulletin are some docks and warehouses belonging to the Pennsylvania Railroad Company, the Northern Central Railroad Company, and others, the roofing and siding material of which is made of asbestos protected metal. "Such concerns as are here represented must have buildings that last—permanent construction with the minimum maintenance expense. For that reason A P M was selected—it forms a light, durable and thoroughly practical roofing and siding material for all kinds of buildings. Bulletin 55 offers more complete evidence of the performance of A P M under all sorts of service conditions. Ask for a copy and a sample of the product."

Plate planers are the subject of a catalogue published by the Covington Machine Co., 82 Wall street, New York. The Covington Machine Company also makes punches, shears, bending rolls and other tools and machines for use in boiler shops.

Brushes of all kinds, especially designed for use in the marine field, are described in the catalogue recently published by the John L. Whiting-J. J. Adams Company, 690-710 Harrison avenue, Boston, Mass. A copy will be sent free to any of our readers on request.

Universal non-packing valves for high-pressure steam, either saturated or superheated, are described in a booklet just published by the Universal Valve Company, 910 South Michigan avenue, Chicago, Ill. The following is an extract from this circular: "Many attempts have been made to produce packless valves and a limited success has been achieved with them under very low steam pressure. But the Universal valve is the first one able to meet the severe conditions of high-pressure steam. The principle of its construction makes packing unnecessary and a leaky valve stem physically impossible."

The Cochran pipe wrench is described in a circular just published by the Cochran Pipe Wrench Manufacturing Company, 7800 Woodlawn avenue, Chicago, Ill. The frame and handle are one solid piece. Rocker with compression strain in our wrench replaces pin with shearing strain in other makes. Guaranteed not to crush nor lock on pipe. Perfect grip and release. Cannot be injured by side pull owing to its solid-frame construction. Jaws drop forged from highest grade of tool steel adapted to the use of wrenches."

Blake pumping machinery is the subject of a circular published by the marine department of the Blake & Knowles Steam Pump Works, 115 Broadway, New York. The battleship *Nevada*, the latest and most formidable dreadnought of the United States navy, is equipped with Blake pumping machinery, covering every service requirement of the ship. The Blake & Knowles Steam Pump Works states that in addition to this *Nevada* equipment, it is to be noted that more than 90 percent of all ships built for the United States navy since the time of the Civil War have been equipped with Blake pumps.

Recovery of Oleite

WE have already stated that once Oleite seizes upon oil it cannot be made to let go of it except by burning. There are two or three ways of doing this very conveniently but this advertisement has no space to describe them.

A frequent question is: "How many times can Oleite be reburned?" We frankly say that we do not know. That it can be reburned anywhere from 6 to 10 times is certain. The point is that the Oleite suffers no deterioration in the burning, except that a certain amount of it crumbles up so fine that it is unfit for use and is fortunately lost in the handling. There is therefore a small "make up" of fresh Oleite each time. This is the measure of the loss, but nobody seems to keep any record of it. For the convenience of our customers we intend in the near future to begin shipping Oleite in cans. When the Oleite is saturated it can be emptied into the same cans and returned to us for reburning—a double quantity being kept on hand by the customer—just like having two pairs of pants for pressing! If experience proves this to be a real convenience we shall establish at least three points, respectively in the east, west and south, where this service can be conveniently rendered. Due announcement will be made.

LEITE TRADE MARK

Our Bulletins give further information.

You can assist us greatly in our publicity work by referring to this advertisement as D10. Our thanks in advance.

WILLIAM ANDREWS, Inc.

120 Liberty Street, NEW YORK

We want a live representative in every city.

Punches, shears, bending rolls, etc., are described by the Covington Machine Company, 14 Wall street, New York, in bulletin No. 11, which has just been published. The Covington Machine Company builds a complete line of fabricating tools for sheet metal, structural shapes, merchant bars, etc., and will build machines to meet special requirements.

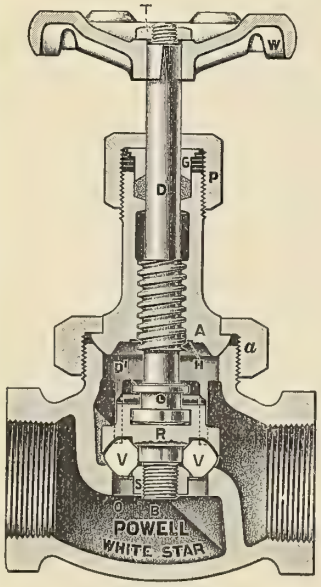
A new blow-off valve, especially designed for marine service, has been placed on the market by the Scully Steel & Iron Company, Chicago, Ill., and is the subject of a circular the company has just issued. These valves are stated to be extra heavy in construction and to pass government inspection. There is no stuffing box, therefore no packing or repairing. They are said to be self-cleaning, self-grinding and not to stick. They are "guaranteed drop-tight for two years or money refunded."

"The Quality Idea at Work" is the title of one of the articles published in the November issue of "Plymouth Products," which is issued by the Plymouth Cordage Company, North Plymouth, Mass. "When a dredging concern has operations extending from New York harbor to Portland, Me., and is working two big dredges, five tugs and eighteen scows on a single job, you can well imagine that its rope orders run into a good deal of money. And you can figure that those orders are going to call for the rope which will yield the biggest return in service. Since the first of the present year the Morris & Cumings Dredging Company, of New York City, has purchased for its various needs miles and miles of Plymouth cordage, and practically every foot of it, we are glad to state, has been our Manila Bolt Rope. When such a concern pays a premium for rope which is to be used largely on such work as tying up and towing mud scows—and does it not merely once or twice but right along—you can be absolutely sure that there really is something to this idea of a high-quality rope paying best in the long run. The same feeling which prompts Morris & Cumings to use our Bolt Rope prompts still other buyers to use regular Plymouth Manila who have previously bought only the cheaper brands of rope has of late, too, greatly lessened the vogue of 'hardware grade' and of its once-popular companions 'second' and 'third.'"

Lunkenheimer "Renewo" valves for marine use are described in booklet No. 535 and in Red Book No. 50, which the Lunkenheimer Company, Cincinnati, Ohio, has just issued. These valves are made in sizes ¼ inch to 3 inches, inclusive (inside screw), and sizes 1½ inches to 3 inches, inclusive (outside screw and yoke), in two patterns—medium for 200 pounds and extra heavy for 300 pounds working steam pressure.

"The Terry Turbine" is the title of an eight-page booklet just published by the Terry Steam Turbine Company, Hartford, Conn. This bulletin gives a general description of various Terry turbine applications, and deals particularly with high, light and mixed pressure turbines. "Ever since the first Terry turbine was put on the market, some ten years ago, the aim has been towards perfection in design rather than cheapening the cost of production. High operating efficiency, long life and accessibility have been considered of more value than first cost. Short-shaft span is obtained by the single wheel in the non-condensing machine and by the use of a composite design for condensing service. This, combined with large shaft diameters, brings the critical speed well above any operating or test speed and eliminates all possibility of whipping. The moderate weight of the rotating element and the long bearings result in low-bearing duties. High-pressure steam is confined to a small chamber at one end of the machine, and the casing being subjected to exhaust pressure and temperature only is in reality a portion of the exhaust piping, and is thus relieved of any appreciable strains. As a result of this low pressure, packing or gland troubles are reduced to a minimum and the low-casing temperature is of particular advantage in maintaining alignment. The casing, bearings, housings and diaphragms (when used) are split on the center line, affording immediate access to every part without disturbing alignment or any pipe connections. About 2,500 Terry turbines are now in operation in all parts of the world, including approximately 400 in the United States and foreign navies, and the large number of machines which have been in constant operation from five to ten years bear witness to the reliability, efficiency and long life of the Terry turbine."

ESTABLISHED IN 1846



"WHITE STAR" VALVE BOOKLET ON REQUEST

POWELL VALVES

(Especially The "White Star" Valve)

MR. ENGINEER:

More than three wise men and numerous others, have used the Powell "White Star" Valves. Our reputation for quality is always maintained by our superior manufacturing facilities which enable us to fill every requirement.

Ask your Dealer for "Powell Valves," or write us

THE WM. POWELL CO.

DEPENDABLE ENGINEERING SPECIALTIES.

CINCINNATI, O.

DIXON'S
SILICA GRAPHITE PAINT

Gives
LONGEST SERVICE
For
hatches, smokestacks,
interior of hulls, boiler
fronts, etc.

Made in
FIRST QUALITY ONLY
for fifty years.

Let us serve you.

JOSEPH DIXON CRUCIBLE CO.

Jersey City, N. J.

ESTABLISHED 1827

B-96

Wiring devices are the subject of a profusely illustrated and handsomely printed catalogue of 168 pages, which has just been published by the Bryant Electric Company, Bridgeport, Conn. The value of this catalogue is much enhanced by a 14-page index to catalogue numbers.

"Sirocco" fans for naval use are described in Marine Series Booklet No. 15, published by the Marine Department of the American Blower Company, 141 Broadway, New York. Almost every navy in the world uses Sirocco fans for some air-handling purposes—forced draft, hold ventilation, etc. The United States ships *Delaware, Florida, Utah, North Dakota,* the torpedo boat destroyers *Walke, Perkins* and *Monaghan* are equipped with Sirocco fans, as are also many of the auxiliary ships belonging to the United States navy.

Direct-connected dynamos and engines are described by the Engberg's Electrical & Mechanical Works, 16 Vine street, St. Joseph, Mich., in a circular the company has just published. "Engberg direct-connected generating sets can be furnished in direct current from 1 to 50 K. W. and in alternating current from 12½ to 125 KVA. They are the result of excellent design, selected material, accurate workmanship, and seventeen years' experience in dynamo and engine-building. An investigation and study of the descriptive bulletins will convince the most adverse opponent."

An interesting picture. In a circular just published, the C. M. Lane Lifeboat Company, 246 Huron street, Brooklyn, N. Y., gives an illustration showing the condition of a metallic lifeboat, which, after saving everyone on board a steamer sunk in the Atlantic, and drifting over a month after the accident, was then picked up and brought to the shops for repairs. This boat was built by the C. M. Lane Lifeboat Company, from approved specifications of the Board of Supervising Inspectors. The sharp dents received bear witness to a terrific banging, but notwithstanding, the boat was still serviceable.

J-M high temperature cement is described in a circular published by the H. W. Johns-Manville Company, Madison avenue and Forty-first street, New York. The following is an extract from this bulletin: "The real function of a firebrick setting is to confine the heat of the fire to a certain definite location. Unfortunately, the material of which firebrick is made has no inherent strength to withstand the stress of contraction and expansion and must fail, through disintegration or spawling, where heating is excessive. It is in correcting these well-known proven defects of firebrick that J-M heat treatment saves money in lengthening the life of firebrick settings. First, by protecting the firebrick edges against the destructive effect of flames by using No. 31 High Temperature Cement as a bond between firebrick courses. This cement vitrifies at a low furnace temperature and forms a solid wall of cement and firebrick. Second, by painting the entire face of the new setting with J-M No. 32 High Temperature Cement all the natural pores, blisters and cracks in the brick are filled up, preventing disintegration caused by temperature variations. Your nearest J-M branch will furnish these cements for your next job."

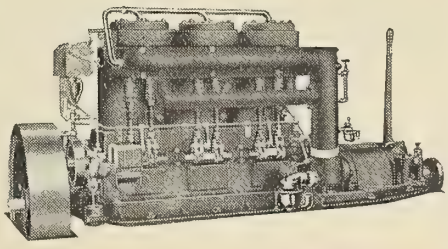
Waugh Glazing Construction is the title of Bulletin 56, just published by the Asbestos Protected Metal Company, First National Bank Building, Pittsburg, Pa. This construction is claimed to be especially suitable for use on steamship piers, warehouses, etc. The introduction to the bulletin reads as follows: "The lighting of any enclosed area has a direct effect upon all operations that are carried on therein. Upon the lighting depend largely the temper and health of the occupants, the quality and quantity of their work and the degree of order and cleanliness that is maintained. Owners and industrial engineers are giving this matter more attention, and practically all agree that the best form of day lighting is obtained from the roof through saw-tooth fronts, skylights, or monitor sash. Experience has shown that on account of of practical defects roof lighting is generally associated with certain drawbacks such as leakage, condensation drip, corrosion, glass breakage, etc. All of these are annoying, increase the cost of maintenance and interrupt production. Complete satisfaction has been considered almost unattainable, and in consequence many architects have abandoned the use of skylights altogether. Durability and cost of maintenance have been sacrificed in order to exploit constructions having but one or two alleged good features, or to produce something which could be sold at a low price. By applying the same scientific principles and thorough methods which have placed other asbestos protected metal products in a class by themselves, we have arrived at what may be safely accepted as practically a perfect solution of roof-lighting problems. Asbestos protected metal glazed structures are invariably safe against deflection, positively water-excluding and corrosion-proof under all conditions of service. In them cost of maintenance has been practically eliminated—and this has been accomplished without increasing the first cost."

WOLVERINE *for* MARINE SERVICE

THE MOTOR WITH THE BORE *and* STROKE

FUELS { KEROSENE (PARAFFIN)
GASOLINE (PETROL)
DISTILLATE
SUCTION PRODUCER GAS

Write for Catalogue No. 73



WOLVERINE MOTOR WORKS BRIDGEPORT CONN U.S.A.
formerly GRAND RAPIDS, MICH.

The New Quadruple-Screw Steamship "Lafayette" of the French Line



Equipped with Welin Quadrant Davits and Lundin Decked Life Boats

This equipment covers the requirements in accordance with the provisions of the International Conference on Safety of Life at Sea.

It provides life boat capacity for all on board, and insures the greatest efficiency and security in time of need.

WELIN MARINE EQUIPMENT CO.

305 Vernon Ave.,
Long Island City, N. Y.

London House { 5 Lloyds Ave.,
London, E. C.

The arc welding outfit made by the General Electric Co., Schenectady, N. Y., is described in circulars just published. According to these circulars, quick and serviceable repairs on all kinds of machines are now made cheaply by arc welding. The General Electric Company makes a portable arc welding outfit consisting principally of a motor generator and panel mounted on a four-wheel truck. Larger sized, non-portable sets are also furnished, capable of operating one or more electrodes.

Three valuable books for engineers. The Wheeler Condenser & Engineering Co., Carteret, N. J., has just published three books for engineers and, describing them, writes MARINE ENGINEERING as follows: "We are handing you herewith three of our books, (1) Steam Tables for Condenser Work, third edition, with which you may already be acquainted; (2) our Psychrometric Tables for Cooling Tower Work, just published, and (3) a combined cloth-bound volume of the two foregoing, also just published. We have thought of putting a price upon these books, but have finally decided that the paper-bound copies will be distributed free to all engineers who request them. The cloth-bound edition is not for general distribution, and a copy is sent you for your own use, and should not be mentioned as available for distribution, because we are unable to send these out indiscriminately. A brief review of the Psychrometric Tables will be found in the enclosed leaflet."

Cost of building tanks cut from one-half to two-thirds by electric welding. This is a statement made in Bulletin B, issued by the C & C Electric & Manufacturing Co., Garwood, N. J. "The costly, slow process of building tanks by punching holes and riveting is now being replaced by electric arc welding, and the job is done in minutes in place of hours Calking is unnecessary and the joints are stronger and tighter. C & C electric arc welded seams are continuous, homogeneous throughout, and of equal strength to the material of the tank itself. The reliability of electric arc welded joints is recognized in its practically universal adoption for locomotive boiler repair and high-pressure container work. Electric arc welding with a C & C welder is also the most economical, quickest and most reliable method of welding for boiler and tank building and repair. We can furnish itemized figures on a large number of jobs, and comparative costs for doing work by electric arc welding and other methods of welding."

"Perfection" rivets for boiler makers, everyone of which is made of specially tested basic open-hearth steel, are described in a circular issued by Anthony Carlin, the manufacturer of these rivets, Cleveland, Ohio.

A gang punching machine with twenty punches is described in catalogue 0-1095, just published by Bertsch & Co., Cambridge City, Ind. Each punch in this machine is gagged so that it may be either engaged or disengaged independently of all the other punches. Bertsch & Company have had thirty-three years' experience designing and building punching and shearing machinery and bending and straightening rolls.

You can increase your output and decrease your costs, according to a circular published by H. Collier Smith, 817 Scotten avenue, Detroit, Mich., by the use of "Quickwork" rotary shears, which cut the most irregular, serpentine or zigzagged lines in sheet metal up to half an inch thick. This machine leaves the metal perfectly flat and true as if blanked out with dies, no kinks or burrs and no cutting in from the side of the sheet

The Babbitt adjustable sprocket rim is described in a circular published by the Babbitt Steam Specialty Co., New Bedford, Mass. "It has long been a great inconvenience, both as to time required and also as to the expense incurred, when you found yourself in need of a chain wheel to operate a valve in an inaccessible place. We have at last solved this problem by supplying a sprocket rim which is adjustable to the rim of the wheel of any valve. No delay, no trouble, small expense. No delay, because your supply dealer can carry in stock an assortment to cover your requirements immediately. No trouble, simply setting up of three nuts. Small expense, about one quarter the price you have previously paid. The necessity of bringing a ladder to the location of the valve which you desire to open or close is, at least, a cause of inconvenience, and may cause loss of valuable time, to say nothing of the danger of a fall. Heretofore, in order to overcome this difficulty, special sprocket wheels have been made for each particular valve and have had to be machined and fitted to the valve stem, causing a long delay and a very large expense, especially in the case of a rising stem, whereas our rim will fit any valve and will not interfere in any way with the rising stem. To attach, adjust the hook bolts to rim of wheel, having the bolt pass through the slot in lugs, center the sprocket rim on wheel and set up on nuts."

In Mr. Webster's Book

the word INDESTRUCTIBLE

is defined thusly

INDESTRUCTIBLE - NOT DESTRUCTIBLE
INCAPABLE OF DECOMPOSITION OR OF BEING DESTROYED

"INDESTRUCTIBLE"
WHITE SHEET PACKING



STYLE NO.10

HAD BROTHER NOAH KNOWN ABOUT
INDESTRUCTIBLE PACKING
HE WOULD HAVE MADE THE DEFINITION STRONGER!
and he would have been right
FOR INDESTRUCTIBLE PACKING IS WONDERFULLY MADE
GUARANTEED TO STAND HIGH AND LOW PRESSURE STEAM, HOT
AND COLD WATER OIL, GREASE, AMMONIA AND ACIDS OF ALL KINDS.

INDESTRUCTIBLE *is the King of all* PACKINGS
WRITE - WIRE OR PHONE FOR SAMPLES, PRICES AND FURTHER
INFORMATION AND COPY OF OUR ENGINEERS CATALOGUE SHOWING
PACKINGS FOR ALL CONDITION OF SERVICE

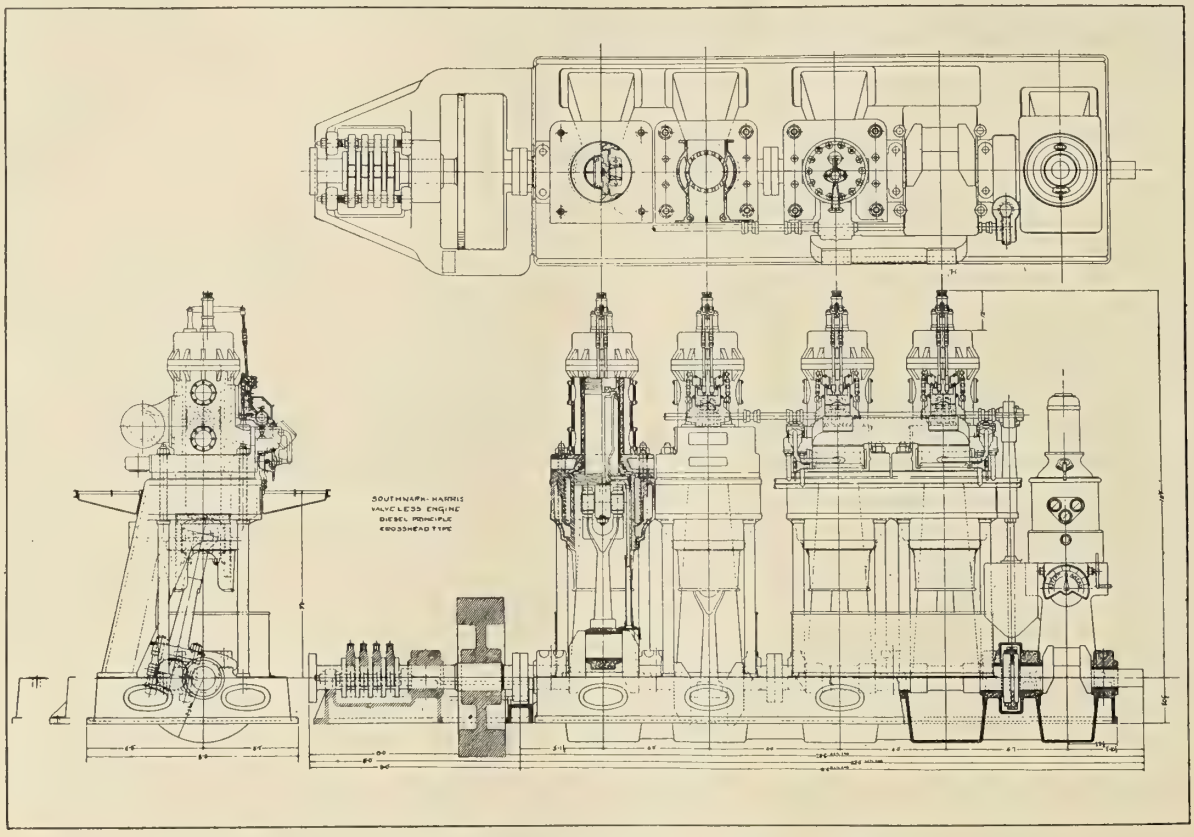
NEW YORK BELTING AND PACKING COMPANY

NEW YORK, N.Y. *91-93 Chambers St.*
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The SOUTHWARK-HARRIS VALVELESS ENGINE

DIESEL PRINCIPLE



Crosshead Type 450 I.H.P. to 2000 I.H.P.

Fuel Cost from 1/5 to 1/2 that of Steam

TWO CYCLE
STEP PISTON
DIRECTLY REVERSIBLE
LOW PRESSURE AIR STARTING
SINGLE WHEEL CONTROL

NO STANDBY LOSSES

SIMPLE
ACCESSIBLE
DEPENDABLE
DURABLE
QUIET RUNNING

THE IDEAL POWER FOR CARGO VESSELS

Designs also for Yachts, Submarines, etc.

SOUTHWARK FOUNDRY & MACHINE COMPANY

400 Washington Ave., Philadelphia, Pa., U. S. A.

Old Colony Bldg.
Chicago

Brown Marx Bldg.
Birmingham

Write for copy of Bulletin 3 I M.

Non-return safety boiler stop valves are described in an illustrated booklet just issued by the Lunkenheimer Co., Cincinnati, Ohio. "The great importance of non-return boiler stop valves for use on a battery of boilers is universally acknowledged, and in some countries their installation is compulsory. It is evident that should a tube be blown out or a fitting ruptured in one of the boilers of a battery, the steam from the other boilers would rush into the header and discharge into the disabled one. An ordinary stop valve would here be inadequate, as considerable time would necessarily be consumed in reaching and closing the valve, and a certain amount of danger must be anticipated. Where Lunkenheimer non-return safety boiler stop valves are used this contingency cannot possibly arise, because a slight reduction of pressure in the damaged boiler will cause the valve to act instantly and isolate it from the others in the battery, preventing damage and possible injury or loss of life. A Lunkenheimer non-return safety boiler stop valve will prevent steam from being turned into a boiler which has been cut out for cleaning or repairs, as it cannot be opened by hand when pressure is on the header side. It can, however, be closed when desired. The valve can be connected in either a horizontal or vertical position."

The Ingersoll-Rand Company, 11 Broadway, New York, N. Y., has issued two new booklets, Forms 76 and 9201. Form 76 is an 80-page catalogue, subject "Water Lifted by Compressed Air." It is a very complete treatise on the Air Lift and explains in thorough detail the air lift system of pumping. To all those in any way interested in adequate water supply a copy of this booklet will be found invaluable, since it very intelligibly presents all the facts essential in analyzing a proposition involving the use of clean water in quantity. Form 9201 is a 128-page 6 x 9 catalogue on Calyx core drills. The principle function of the core drill is the determination of the character, order, thickness and extent of the materials beneath the earth's surface, by means of cylindrical cores which it extracts. In coal and metal mines, stone quarries, contract work or for canal or tunnel developments projected, the core drill is used and takes what is otherwise an unknown quantity and converts it into an absolute certainty. By determining the actual conditions in advance, it is a medium to save thousands of dollars in machine equipment, underground workings, etc., that might otherwise be expended only to find a barren property. Booklet is illustrated, gives size and capacities of the different types and shows the apparatus in operation in the various fields.

The Stow flexible grinder is the subject of a circular just issued by the Stow Manufacturing Co., Binghamton, N. Y., and is described as follows: "The Stow flexible grinder, adjustable, is designed and built especially for the steel industry and allied trades. The motor shaft combination is mounted on a truck, making it easily transported to any part of the shop, eliminating the necessity of taking the work to the tool, thus saving time and cutting cost. The motor is ruggedly built, being totally enclosed with the starting equipment incorporated within the motor frame, thus giving a compact construction. The best of material and workmanship is used in the construction of this equipment and all the material used therein as well as the completed parts are thoroughly tested in ours laboratory. In our D. C. equipment the variation in speed is secured by means of a plunger in the pole piece, which operates to change the reluctance of the magnetic circuit. No power is lost in this operation, as is the case in most variable speed motors, and the full load efficiency remains practically the same at all speeds. This speed variation allows for the consuming of worn emery wheels down to the minimum, insuring proper cutting speed regardless of size and giving the highest efficiency. Another important characteristic of the Stow multi-speed motor is its ability to stand sudden overloads, which it does without dangerous sparking. The motor is so balanced on the truck that it may be adjusted to the proper angle for all purposes and to meet all grinding conditions. The weight of the flexible shaft is taken off the operator. The motor shaft combination may be had for any current and adds to the already large list of Stow tools, which are tools of proven value. A portable grinder which meets not only ordinary grinding conditions but is adaptable to unusual conditions. It may be used on small castings as well as large and enables the operator to work over a large area. The emery wheel on the driven end of the shaft may be interchanged with a scratch brush should the work demand. The Stow flexible grinder, adjustable, is also furnished for A. C. current, but motor does not regulate any cycle or phase. The tool is built in several sizes, according to the capacity of the emery wheels desired. It has been designed to give the maximum grinding efficiency in all cases. We are glad to furnish at all times further details upon request. Any operating official cannot afford to overlook the merits of the Stow flexible grinder, adjustable."

BERNSTEIN METAL BERTHS



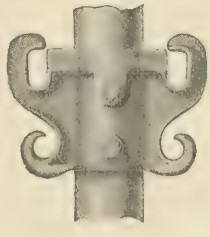
Bernstein No. 5550 Folding Berth, installed on U.S.S. "Newark," Providence Harbor.

"STANDEE BERTHS ONE OF OUR SPECIALTIES." We have built them in quantities for the largest shipbuilders in the U. S.

Manufactured in their entirety in a plant which is one of the oldest, largest and best equipped metallic bed and bedding factories in the country.

A complete, practical and efficient line is offered. "A berth to successfully meet every condition on board ship." Also brass and iron beds, mattresses and pillows.

We describe them fully in a catalog which should be on your files. WRITE FOR IT — SPECIFYING CATALOG NO. 17.



One of the distinctive features on our No. 5550 Folding Berth. The berth cannot work out of the supporting socket.

BERNSTEIN MFG. COMPANY, Dept. C., 3rd & Allegheny Ave., PHILADELPHIA, PA.

Monel Metal is the title of a handsomely printed catalogue published by the Bayonne Castings Co., Bayonne, N. J. Monel metal is described as being a metal having the strength of steel with a high non-corrodibility that has been the long-felt want in engineering and mechanical fields. According to the manufacturer, this place has been filled by Monel metal in a way that has exceeded all expectations. In manufactured forms, Monel metal comes in great variety. A few of these are as follows: Tubes, rivets, valve seats, discs, steams, marine condensers; bolts, and nuts, pump liners, pump rods, propellers (large and small from battleships to small launches), propeller shafts, and boat trim such as deck fittings, stern bushings, rudders, struts, stuffing boxes, shaft sleeves, etc., refrigerating machinery and refrigerators, valves for combustion engines, etc.

BUSINESS NOTES

STEAMERS RECENTLY FITTED with the Ross Schofield system of circulation, made by the Ross Schofield Company, 17 Battery Place, New York:

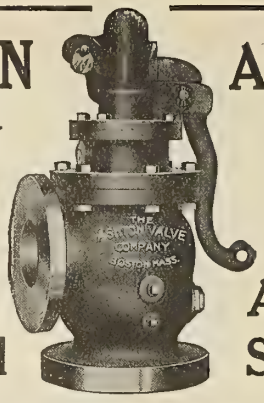
Steamships	Line	Number of Furnaces
Massachusetts	Atlantic Transport	18
Maryland	" "	12
Missouri	" "	12
Maine	" "	9
Samarinda	Rotterdamasche Lloyd	18
New steamer	Harland & Wolff	64
New steamer	" "	96
New steamer	" "	36
Cameronia	Anchor Line	45
California	" "	36
Magnetic	White Star	6
Afric	" "	12
Daishin Maru	Yonei Shoten	3
Kawasaki Dockyard	" "	36
Steamer	" "	6
Frank Parish	Arthur Holland & Co.	8
Lomas	" "	6
Neuquen	" "	9
Tandil	" "	8
Azul	" "	6
Purelight	American Petroleum Co.	9
New York	" "	12
Cardiff	Fisher & Co.	3
Margarite	Thames Steam Tug Co.	2
Constance	" " "	1
Maud	" " "	2
Lettie	" " "	2
Sunshine	W. H. J. Alexander	2
Sunclad	" "	2
Sunlit	" "	2
Sunbeam	" "	2
Sunfly	" "	2
Sunrise	" "	2
Sunbird	" "	2
Sunfish	" "	2
Sun I	" "	2
Sun II	" "	2
Sun III	" "	2
Sun IV	" "	2
Sun V	" "	2
Sun VI	" "	2
Clive	" "	1

RECENT ORDERS for oil engines received by Bolinders Company, 30 Church street, New York, are as follows: Bark *Carmela,* Mobile, two twin 160 brake-horsepower, two-cylinder marine oil engines, Model "M I"; Smith Shipping Company, Inc., six 320 brake-horsepower, four-cylinder marine oil engines, Model "M II"; sugar transport boat *Cuba,* one 65 brake-horsepower, two cylinder marine oil engine, Model "E I"; J. B. King Company, for barges now lying at Staten Island Ship Building Company, two 160 brake-horsepower, two-cylinder marine oil engines, Model "E I"; schooner *Alembic,* W. & S

ASHTON ASHTON

Pop Safety Valves — Steam Gages

The Quality Standard — The Accuracy Standard



No. 16 Style Marine Valve

THE ASHTON VALVE CO., BOSTON, U. S. A.

New York — St. John's House, London, Eng. — Chicago

ROSS SCHOFIELD BOILER CIRCULATORS

OVER 3,000,000 HORSE-POWER INSTALLED OR ON ORDER

ROSS SCHOFIELD COMPANY

17 BATTERY PLACE — NEW YORK CITY

CEDERVALL'S PATENT

Protective and Lubricating Boxes

FOR PROPELLER SHAFTS

Are fitted to more than 3,000 Steamers, with shafts ranging between 1½ in. and 20⅝ in. in diameter.

Our system insures maximum safety of propeller shafts, as these are running in oil, consequently no corrosion. . . . . The costly liners on shafts may therefore be dispensed with as being absolutely superfluous. . . . . .

FRICTION MINIMISED

Consequently

—POWER SAVED.—

Old Stern Tube Arrangements can be altered for application of this Lubricating Box at a very Nominal Cost. . .

MAKERS:

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GOTHENBURG, SWEDEN.

AGENTS—*England, East Coast:* Jos. JOHNSON, Newcastle-on-Tyne. *England, West Coast:* MAXTON & SINCLAIR, Liverpool. *Scotland and Ireland:* JOHN G. KINCAID & Co., Ltd., Greenock. *Norway:* I. von der LIPPE, Christiania; C. DAHM, Bergen; OLAF BERG, Stavanger. *Netherlands and its Colonies:* N. V. SOERABAYASCHE MACHINENHANDEL, v/h Becker & Co., The Hague. *Italy:* DOTT. ATTILIO PANZANO, Genova. *U.S.A., West Coast:* LOUIS WILHELMSON, United Engineering Works, San Francisco, Alameda and Oakland.

REG'D TRADE MARK

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COMPOSITIONS FOR IRON AND STEEL VESSELS' BOTTOMS

In use and in stock at all ports of the world. Over 18,000,000 gross tons of shipping coated annually

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HOLZAPFELS AMERICAN COMPOSITIONS CO., Offices, Welles Bldg., 18 Broadway, N. Y.

HOLZAPFELS, LTD., Milburn House, Newcastle-on-Tyne, England.

Job & Company owners, two twin 50 brake-horsepower, two-cylinder marine oil engines, Model "E I"; Manufacturers & Merchants' Lighterage Company, one 320 brake-horsepower, four-cylinder marine oil engine, Model "E II"; schooner *Chiriqui,* Enrique Halpen owner, one 80 brake-horspower, two-cylinder marine oil engine, Model "E I"; Alexander & Baldwin, for Hawaiian Islands, one 240 brake-horsepower, four-cylinder marine oil engine, Model "M II"; The Texas Company, for auxiliary trader, two twin 320 brake-horsepower, four-cylinder marine oil engines, Model "M II." In addition to which there are the twelve 500/600 brake-horsepower, four-cylinder marine oil engines, Model "M II," on order for the oil tankers now building at the Baltimore Dry Docks & Ship Building Company, for Motor Tank, Ltd., of Christiania, Norway.

NEW 3,000-HORSEPOWER MOTOR SHIP.—An order has just been placed with the Werkspoor Company, Amsterdam, by a Norwegian shipowning firm for a 6,500-ton D. W. C. cargo motor-driven ship, making the twenty-fifth Diesel ship built, or on order, with this concern. This vessel will be equipped with two Werkspoor-Diesel engines of the direct-reversible, single-acting, four-cycle type, developing about 1,500 indicated horsepower apiece, at 120 revolutions per minute. The interesting part of this order is that these engines will be a distinct advance upon previous Werkspoor motors, because hitherto all engines over 1,000 horsepower have been in six cylinders, whereas in the present instance the number of cylinders will be reduced to four, each having a bore of 24¾ inches by 47¼ inches stroke, thus reducing the number of parts by about 20 percent. In their marine steam engineering department the Werkspoor Works are also extremely busy, having fifteen sets of 1,000 to 6,000 indicated horsepower each for commercial craft alone, apart from a great amount of marine turbine work, of which one set alone is of 65,000 horsepower. Many shipowners and others will remember with pleasure that genial engineer from the Werkspoor Diesel Works, Amsterdam, Mr. Girard Lugt, who was over here last summer, but will be sorry to learn that he recently had a narrow escape from losing his life. In the last Zeppelin raid on London, where Mr. Lugt happened to be on business, a couple of bombs dropped some 20 feet away from him, but, fortunately, he was unhurt.

ORDERS for Eckliff automatic boiler circulators. The Eckliff Automatic Boiler Circulator Company, 46 Shelby street, Detroit, Mich., has received orders from the New York Shipbuilding Company, Camden, N. J., covering the installation of 24 Eckliff circulators in ships the New York Shipbuilding Company is building for the Coastwise Transportation Company, and 8 circulators in ships for the Pocahontas Navigation Company.

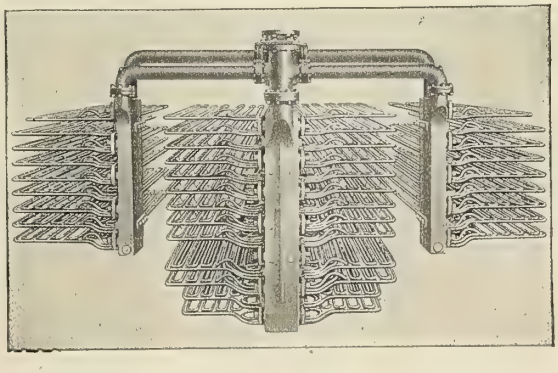
THE C. M. LANE LIFE BOAT COMPANY, 246 Huron street, Brooklyn, N. Y., reports great activity in the line of power and pontoon lifeboats, employing more than forty boat builders. While the Seamen's Act does not seem to affect the coastwise ships, so far as lifeboats are concerned, as they are well fitted with lifeboats for all on board, there are still lifeboats to be supplied to the trans-ocean liners when running with full passenger capacity. The Lane Company states that "the present type of metallic lifeboat, as prescribed by the Board of Supervising Inspectors, seems to be the one preferred, on account of the service it gives. In addition to the regular open boats the trans-ocean liners carry a large number of the Englehardt type of collapsible lifeboats, which are now rated as 2C pontoon lifeboats, according to the latest rules of the Board of Supervising Inspectors. The only change in their construction is that a patent device is attached to the sides of the boat, affording means of quickly clearing the decks of water. These orifices were invented by Captain Engelhardt, and are such that the water cannot enter the boat through them when they are intermittingly submerged. The boat will clear 2 tons of water in less than 20 seconds, about one-half of the water running out the first 5 seconds and two-thirds in 10 seconds. The C. M. Lane Life Boat Company is also building this type of lifeboats at Sorel, Canada, under the supervision and approval of the Canadian Department of Marine."

A NEW OIL ENGINE has been placed on the market by the Burnoil Engine Company, 1120 High street, South Bend, Ind. The manufacturer sends us the following description of this engine: "All recognize the fact that steam engines, while now the standard of power, have a low thermal efficiency; in other words, are extremely costly to install and operate. Students of the power problem are looking for relief and many look to the internal-combustion engines to improve the situation.

FIRE TUBE MARINE SUPERHEATER

EIGHT REASONS WHY:

1. It is adaptable to either new or existing boilers of the fire tube type and can be applied with no change in design or construction.
2. It renders possible increase in output of boiler horse power from a given boiler plant, 10% to 20%.
3. It will produce the same power output with fewer boilers.
4. It reduces the size of the bunkers, thereby reducing the draft of the vessel with a given cargo or making possible an increase in revenue cargo.

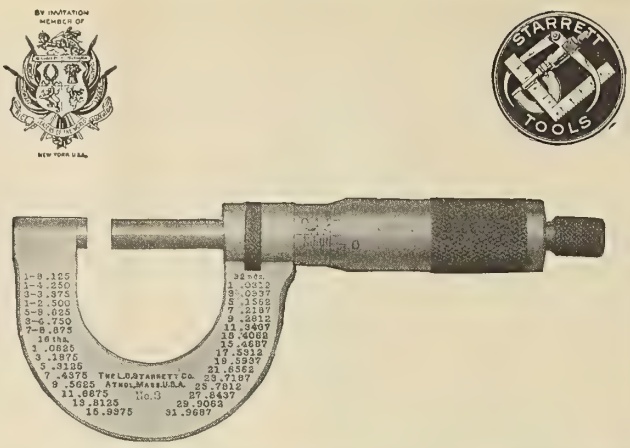


5. It results in a saving of fuel over saturated plants, both operating under the same draft conditions, of 10% to 20%.
6. It reduces the maintenance costs by the prevention of water hammer, leaky flanges and condensation in the cylinders.
7. It does not prevent rapid, thorough and frequent cleaning of the tubes.
8. Its construction provides easy access to all screwed joints and the easy removal of the parts.

LOCOMOTIVE SUPERHEATER CO.

30 Church St., New York, N.Y. **People's Gas Bldg., Chicago, Ill.**

While the modern gasoline engine has become a wonderful machine, it can hardly hope, with its expensive fuel, to project itself into a wider field than it now occupies. Owing to the great increase in the production of petroleum, and especially of those grades lean in gasoline but rich in fuel oils, people are expecting the internal-combustion oil engine to advance and occupy a larger field. The hot ball type of oil engine has patent defects that condemn it, yet brings a hint of the future. The Diesel engine comes with a larger promise, its principle of operation is a great step in advance, but its complicated method of applying this principle in a large measure defeats the victory gained, and a step nearer the ideal must be taken before the internal-combustion engine can come into its rightful position as a new and higher standard of power. In the Burnoil engine, as built by the Burnoil Engine Company, South Bend, Ind., there is evidence that this step has been taken, as few people realize how near this engine has come to fulfilling the requirements of an ideal engine. We can hardly conceive of an internal-combustion engine without a piston, connecting rod, crankshaft and governor device, and if it be a four-cycle engine it must have inlet and exhaust valves. Users of an internal-combustion engine do not want anything more complicated, but in the majority of engines there are many additional and complicated parts, particularly the carburetor and ignition system. In marked contrast the Burnoil engine has only one additional moving part, namely, a small poppet valve to open and let the oil flow in by gravity. The fuel oil is fed through a pipe to an inlet from the oil tank by gravity, and, of course, must be liquid enough to flow freely, thence the oil passes a valve (which is operated by a governor) to the seat of the valve. This opens during the suction stroke, admitting the required amount of oil to the fuel cup. During the compression stroke of the piston, pure air is taken into the cylinder and compressed. This compressed air attains a temperature of 1,000 degrees F. as it enters the fuel cup through two small holes. At the point of highest compression (when piston is nearest the cylinder head) the heat of the compressed air explodes a little vapor from this oil, and the force of this explosion sprays the remaining oil out through these small holes meeting air in the compression space at the head of the piston heated to 1,000 degrees F. by its compression, when it burns, expands and drives the piston on its power stroke. This additional moving part, the fuel valve, is adjusted in the factory, and needs no adjustment thereafter, so that the only adjustment to be made on these engines after they leave the factory are the adjustments common to any engine—that of governor to regulate the speed to that required for the work. Of course, these engines must be kept lubricated, furnished with water for cooling and oil for power, but it seems remarkable that when effort was made to improve the gasoline engine so that it would burn heavy oils, this improvement was accomplished by simplifying the gasoline engine rather than by adding new parts. This improvement in Burnoil engines is scientifically correct, as experiments show that heavy oils cannot be vaporized completely by heat. For this reason they cannot be used in the carburetor of the common gasoline engine, and when used in engines of the hot ball type, the oil is not completely vaporized by the hot ball or plate, and consequently the heavier parts are turned into troublesome carbon deposits. As in the Diesel engine so in the Burnoil engine, the oil is not vaporized but atomized or blown into a fine mist. In this way scientifically correct combustion is secured, the oxygen in the air is thoroughly mixed with all the minute particles of oil, mist and heat being present, there is instant ignition and complete combustion. This type of engine has been successfully manufactured in Europe for a decade. The inventor, Brons, began in Holland, and now the following firms manufacture engines under Brons patents: Brons (inventor), Appingedam, Holland; A/s Frichs, Aarhus, Denmark; Gasmotoren Fabrik Deutz, Cologne, Germany; The Prager Maschinebau A. G., Prague, Austria; Messrs. Samuel White & Company, Ltd., Cowes, England. The Burnoil Engine Company has purchased the exclusive right to build marine engines in this country under the American patents of the Brons type of engine, and also has a license to build stationary and portable engines, and has exhibited at a number of State fairs this year its line of horizontal farm engines. The simple way in which Burnoil engines burn heavy oils down to 28 degrees Baume without spark, carburetor, hot ball, or compressed air for injection, and, moreover, start on these oils even in the coldest weather without any preheating or gasoline, is a strong selling factor, but when the power-using public becomes acquainted with the fact that they are much cheaper to install and operate than steam, and that they are thoroughly reliable and dependable, their rapid introduction into all fields will be assured."



Extreme accuracy means extreme care and extreme skill in making—extreme quality. These are the characteristics of

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and Instruments of Precision

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Athol, Massachusetts

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GRAND CENTRAL PALACE
NEW YORK

Opens Saturday, January 29th
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Being specified by leading Marine Architects and installed by representative AMERICAN SHIPBUILDERS and SHIPOWNERS

Six Standard Sizes to meet all usual conditions

ROBERT BRUCE STEWARD
17 Battery Place New York

Modified types designed to meet special conditions

HELP AND SITUATION AND FOR SALE ADVERTISEMENTS

No advertisements accepted unless cash accompanies the order.

Advertisements will be inserted under this heading at the rate of 4 cents (2 pence) per word for the first insertion. For each subsequent consecutive insertion the charge will be 1 cent (½ penny) per word. But no advertisement will be inserted for less than 75 cents (3 shillings). Replies can be sent to our care if desired, and they will be forwarded without additional charge.

Wanted—Young man to sell an established appliance to marine trade. Must have practical knowledge of marine engines. State age, experience, references and approximate salary desired. Address *Marine,* care of INTERNATIONAL MARINE ENGINEERING.

Salesman, aged 28, with nine years' experience in yacht, commercial, vessel brokerage and marine products, wants position. Is well acquainted among shipyards. Address *Salesman,* care of INTERNATIONAL MARINE ENGINEERING, 17 Battery Place, New York.

FOR SALE

3-Triple effect 18 coil Yaryan evaporators, capacity 15,000 pounds water per hour.

2-8 Coil triple effect Yaryan evaporators, capacity 6,600 pounds of water per hour complete with preheaters, condensers, separators and intermediate piping.

Machines as good as new. Attractive price to prompt purchaser.

ALUMINUM ORE COMPANY, East St. Louis, Illinois

WANTED

Complete sets of INTERNATIONAL MARINE ENGINEERING for the years 1910, 1913 and 1914; or bound volumes of each year in good condition. Write us, stating price asked.

International Marine Engineering

17 BATTERY PLACE, NEW YORK

MARINE REFRIGERATING PLANTS.—The Brunswick Refrigerating Company reports the following sales since those given in the December issue: To W. R. Grace & Company, two 4-ton compressors for each of their new steamers now being built by William Cramp & Sons Ship & Engine Building Company. Ocean Steamship Company, of Savannah, a 2-ton plant for the steamship *City of Savannah.* The order was received for equipping this steamer late Saturday afternoon after everybody had left. Orders for the necessary material were gotten out on Sunday morning; men were obtained to run the necessary apparatus, and the plant was shipped Sunday night. It was delivered in New York on Monday morning, and the plant was erected complete by Tuesday night. That is, in 72 hours from the time the order was given, the plant was operating. Through the Maryland Steel Company orders have been received for a 1-ton plant for the last Munson Steamship Company's vessel now building there, and for 4-ton plants for each of the Bull Insular steamers, and for 2-ton plants for each of the Standard Oil Company of New Jersey tankers. Through the Newport News Shipbuilding & Dry Dock Company orders have been received for a 1-ton plant for the Munson Steamship Company, and for two 2-ton compressors for the new Mallory Steamship Company's steamer, now building, to replace the steamship *Denver.* Through the Seattle Construction & Dry Dock Company we have received orders for two 4-ton compressors for each of the new freight steamers now building at Seattle for the New York & Cuba Mail Steamship Company. A new list of marine installations, containing the names of about 300 steamers equipped with Brunswick marine refrigerating and ice-making plants, is now obtainable by applying to the Brunswick Refrigerating Company, Marine Department, New Brunswick, N. J.

MARINE SOCIETIES.

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AMERICAN SOCIETY OF NAVAL ENGINEERS
Navy Department, Washington, D. C.

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29 West 39th Street, New York.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS
29 West 39th Street, New York City.

UNITED STATES NAVAL INSTITUTE
Naval Academy, Annapolis, Md.

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National Secretary—M. D. Tenniswood, 308 Vine St., Camden, N. J.

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President—J. Emile Schmeltzer, 221 Cumberland street, Brooklyn, N. Y.
Vice-President—H. A. Hope, Newport News S. B. & D. D. Co., Newport News, Va.
Secretary—B. G. Barnes, 40 Faxon avenue, Quincy, Mass.
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GREAT BRITAIN.

INSTITUTION OF NAVAL ARCHITECTS
5 Adelphi Terrace, London, W. C.

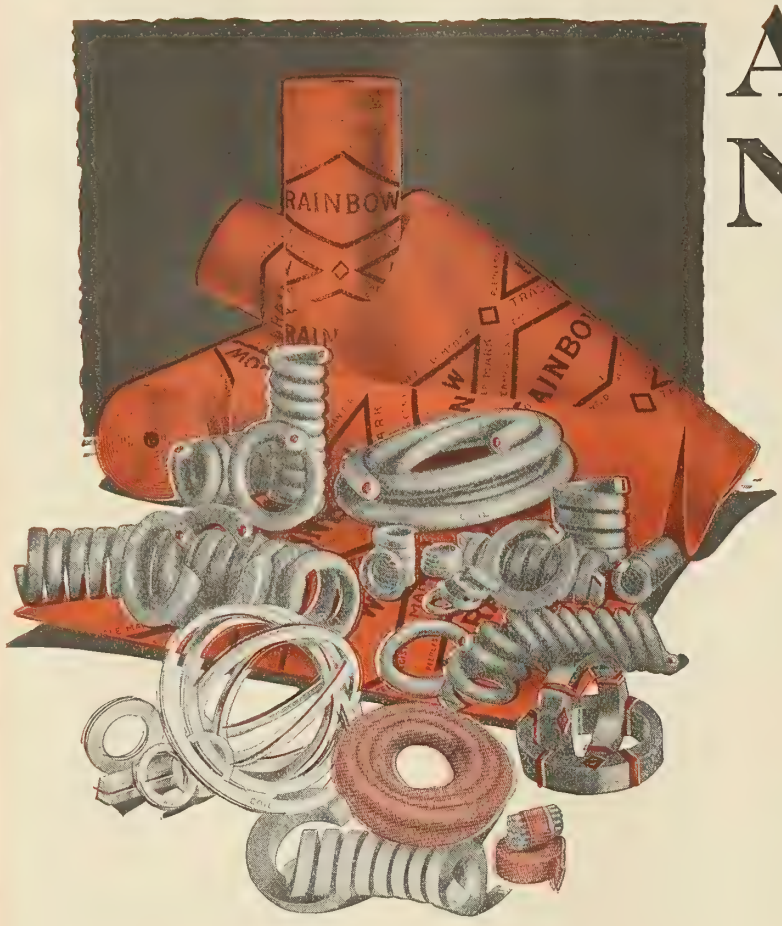
INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND
39 Elmbank Crescent, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS
Bolbec Hall, Westgate Road, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORP.
The Minories, Tower Hill, London.

A FREE SAMPLE SPOOL of "Palmetto" packing will be sent to any of our readers, upon request, by Greene, Tweed & Company, 109 Duane street, New York. Greene, Tweed & Company call attention to "the convenience of packing any size of valve from one spool of 'Palmetto' twist packing. You just unstrand to the desired size, and at the same time you know that the valve will remain tight. It is the lubrication in each strand of high tensile strength that gives 'Palmetto' the long life in service."

THE WEIMER CHAIN & IRON COMPANY, Lebanon, Pa., manufacturer of hand-made chains and hand-made forgings, has just completed a large order for chains for first-class and second-class buoys and bell buoys for the Cuban Government. We understand this concern has booked orders for a large tonnage of anchor chains, which, in connection with its regular trade for steam shovel, dredge, foundry, conveyor, quarry and other hand-made tested chains, will keep all departments busy.



A HAPPY NEW YEAR

AND MANY OF THEM

May 1916, for YOU and YOURS, be full of good things that make life a pleasure, and your allotment of health, of wealth and happiness be of full measure.

An old wish, 'tis true,
But—it's our wish for YOU

ONE way to make "life a pleasure" is to cut all worry. If you worry about your packing problems, let

PEERLESS PACKINGS
take care of your worries.

They're the greatest gray hair eliminators that exist and are for every service (no exception) found in modern power plant practice, no difference where nor what. And they have some A-1 "runners up" in our Belting, Hose and Molded Goods.

Send for a copy of—
THE PEERLESS PHYSICIAN
and begin 1916—right.

PEERLESS RUBBER MFG. CO.

31 Warren St. NEW YORK

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Marine Refrigerating
and
Ice Making Plants
Over 300 vessels equipped
Send for new free booklet
"Marine Installations"
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Eckliff Automatic Boiler Circulators

Wishing You A Glad and Prosperous New Year

We Thank You—

thank all of you who stop here long enough to let us. For that means you'll get "Eckliff Circulators" into your *consciousness*—and it's only a short step from that to getting them into your *boilers*. When you get them in your boilers *you'll* thank *us*.

We take this opportunity, also, to express our sincere appreciation for the generous measures of prosperity which came our way during nineteen-fifteen. We know that *business* is good because *our Circulators* are good.

We believe that the men who contributed to *our* season's success have reason to congratulate *themselves*. And we hope that *you* will soon get in touch with us and avail yourself of the sure savings which inevitably follow the installation of Eckliff Circulators.

WRITE US TODAY.

Eckliff Automatic Boiler Circulator Co.

46 Shelby Street, Detroit, Mich.

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Eckliff Circulators are fully protected by U. S. and foreign patents.

Don't Forget to "Watch the Thermometer"

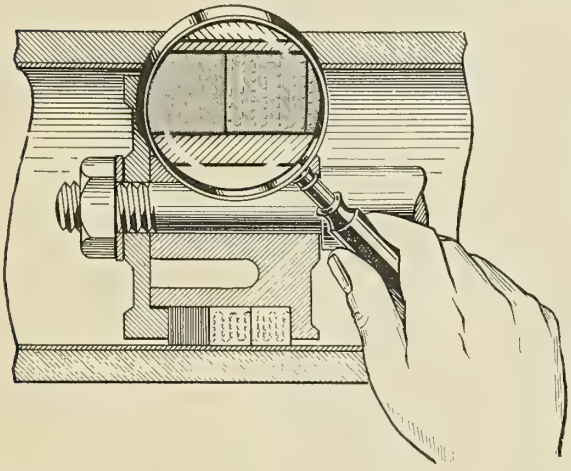
Create and Maintain Perfect Circulation

JOHNS-MANVILLE SERVICE

JOHNS-MANVILLE SERVICE COVERS THE CONTINENT

J-M RESPONSIBILITY—the logical outgrowth of over half a century's progress, achievement and business integrity—stands as a stronger assurance for your satisfaction than even the most complete written guarantee.

We'll leave it to you—which of these packings will stand side-swiping the better?



Here are two inside packed pistons. One packed with laminated hydraulic packing, the other with J-M Universal. You know what the action of the cylinder wall on these packings is—a swiping side-pull. The packing really sweeps the cylinder wall.

How can any built-up fabric packing stand this action continuously? What is there to reinforce it against this side-swipe? Nothing except the strength of the rubber between the leaves.

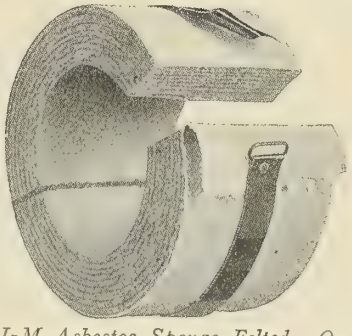
Look at the construction of J-M Universal, notice "fold in the fabric" and how it takes up the side action and resists end wear.

Toughest rubber cement is combined and moulded with the fabric under heat and pressure.

If you want a good return on your heat insulation investment, give J-M Insulation Service the job

A steam plant must be at the highest possible efficiency. That's why you are so careful to keep your boiler evaporation as high as you can. For this same reason you must watch the coal pile, do careful firing and keep your condenser vacuum at the low point. But what about the heat that is silently leaking all along the line? Is your pipe covering an insulation? It should be—if your plant is to be efficient.

There is a J-M Insulation for every condition. Skilled specialists are ready to confer with you about them and a corps of men near you to apply the proper insulation, properly. Let us in on the very next job you have.



J-M Asbestos Sponge Felted. One style of J-M Heat Insulation

H. W. JOHNS-MANVILLE COMPANY

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TALBOT

Steam Power Plants



THE accompanying illustration shows a 150 horsepower, a 50 horsepower and a 1,000 horsepower boiler under construction at our works at Olean. A copy of test of 150 horsepower (engine horsepower) at one-half its maximum power under forced draft was published in last month's advertising. The 1,000 horsepower boiler shown is being installed in one of the Pennsylvania Railroad Company's tugs. A similar boiler is being built for a high-speed yacht. the details of which will be given at a future date. We have many other sizes under construction and ordered at the present time, from 50 horsepower to a thousand. Tests and a number of years of service have shown Talbot Boilers to cost less per horsepower year than any on the market. They weigh less, occupy less space, are more durable, and are absolutely safe, require no lay-up or cleaning periods, and combined with one of our 4-cylinder engines will operate for less than any other type of steam or heavy oil engine, therefore they are ideal, because of their compactness, light weight and durability for shallow draft barges, auxiliary sailing vessels, tugs, as well as pleasure and fishing vessels, submarines and stationary uses where fuel-oil is available.

TALBOT BOILER COMPANY

120 LIBERTY STREET **NEW YORK CITY**

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G-E MOTOR OPERATING DREDGES


G-E MOTOR OPERATED LIFT BRIDGE

Port Adjuncts Safely and Reliably Operated by G-E Motors

Protect the lives and property of those dependent on the reliable operation, of harbor and port mechanical devices.

Dredges, elevators, dry docks, fire tugs, bridges, freight handling machinery, etc., are being safely and reliably operated by G-E motors. Maintenance cost has been greatly reduced wherever G-E motors have been used.

Entire sections of the waterfronts of leading cities in the United States and Canada have been electrified by the General Electric Company.

Let our specialists make a proposition to fit your requirements.

General Electric Company

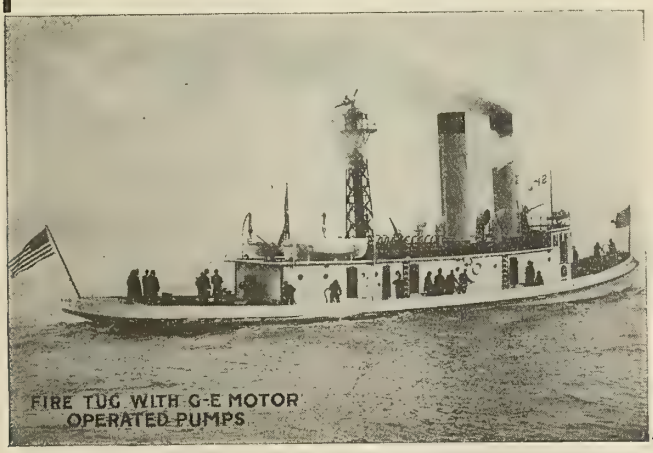
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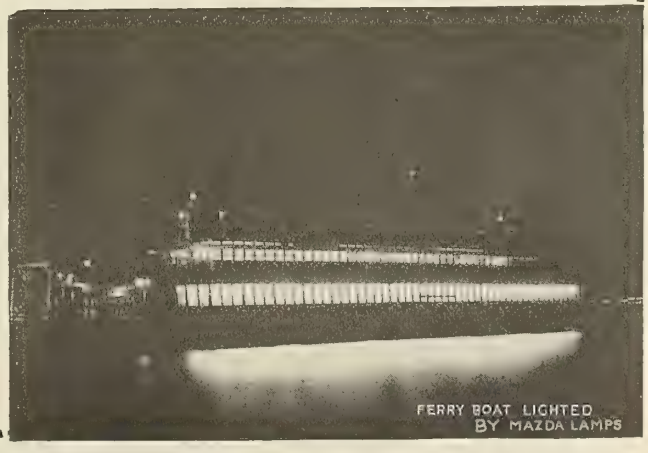
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5871


FIRE TUG WITH G-E MOTOR OPERATED PUMPS


FERRY BOAT LIGHTED BY MAZDA LAMPS



Reliability—

a requirement demanded of all marine power plant equipment.

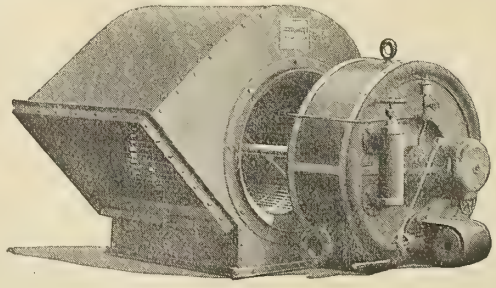
Along with reliability comes economy of operation, of maintenance, and of space. From the fact that almost every Navy in the world use "Sirocco" Fans for some air handling purpose—forced draft—hold ventilation, etc., is evidence that "*Sirocco*" *Fans possess these qualities.*

The U.S.S. Delaware—Florida—Utah—North Dakota—The Torpedo boat destroyers Walke—Perkins and Monaghan are equipped with "Sirocco" Fans. Many of the U. S. Navy auxiliaries are carrying "Sirocco" Forced Draft equipment.

There is another admirable feature about the "Sirocco" Fan, it—

Responds to the Demand

for a uniform—continuous—economical service.
The outfit illustrated at the right is one of 3 "Sirocco", turbine driven outfits installed in a Chinese training ship.



Catalogues and bulletins will be sent at your request. Please mention Marine Series No. 15.

Marine Dept., 141 Broadway, New York, N. Y.

AMERICAN BLOWER COMPANY

DETROIT, MICHIGAN, U.S.A.

The "Renewable"

EXTRA HEAVY

GLOBE

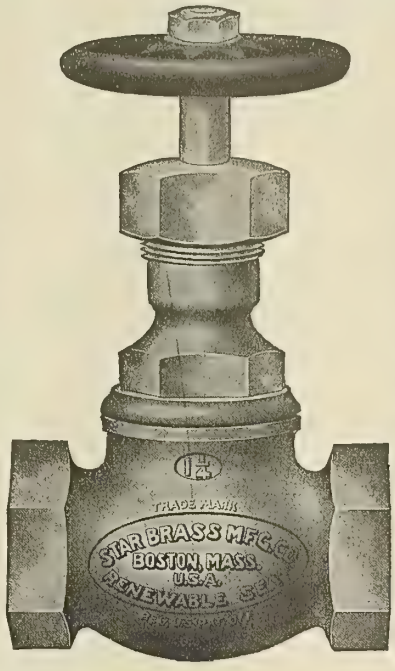
The most modern and thoroughly up-to-date globe valve at present on the market. By far the best globe valve for marine service yet produced, it being particularly adapted for high pressures, also for general severe marine work.

SOME OF OUR SPECIAL FEATURES ARE ENUMERATED BELOW:

All castings of our special bronze mixture, made from metal patterns on pneumatic molding machines.

All parts made with special tools, insuring absolute uniformity.

Body of special rugged design; steam is not retarded in its flow owing to body's form—it is so



MARINE

VALVE

designed that metal is distributed where most needed for severe use.

Seat and Disc are both Renewable and extra heavy; the bevel or taper of both is at a sharp angle, with a very light bearing, insuring less liability of foreign matter lodging on seat when valve is closed, also less chance of wire drawing and cutting.

Seat rings are of a "Patented" form with special taper seat where screwed in body. This design insures a perfect joint and absence of liability to distortion from lack of care in installation or unequal expansion in use.

The bonnet is novel in design, having many unique features. First, it is absolutely self-draining, thereby eliminating all liability to freeze when used in cold positions; has extra large and deep packing space, gland and nut. Long thread in body, insuring strength and tightness.

Stems or spindles are extra heavy, made with large "Acme" quick-opening threads.

Valves can be re-packed under pressure, when wide open, as top of discs seat against bottom of bonnet, making steam-tight joint.

Handwheel is fastened to stem with hexagon nut, and can readily be removed and replaced.

Manufactured by STAR BRASS MANUFACTURING CO.

Main Office and Works: 104 to 114 East Dedham St., Boston, Mass.

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The McNab

"CASCADE" BOILER CIRCULATOR and FUEL ECONOMIZER

PATENTED

13% ACTUAL SAVING IN COAL

READ THIS REPORT FROM

W. C. RICHARDSON & CO.

CLEVELAND, OHIO

"The Steamer 'Norton' in 1913 burned 4,600 tons of fuel, in 1914 she burned 3,600 tons. This shows your Circulators saved some fuel; the same applies to our Steamer 'Miller' and Steamer 'Hubbard.' The boats did not run as many miles in 1914 as in 1913, but you can SAFELY say there was a saving of 600 tons per vessel."

AMERICAN-HAWAIIAN S. S. CO. reports:
S.S. "Mexican" saving 16½% on oil fuel,
S.S. "Columbian" saving 13½% on oil fuel.

CAN YOU AFFORD TO NEGLECT THIS?

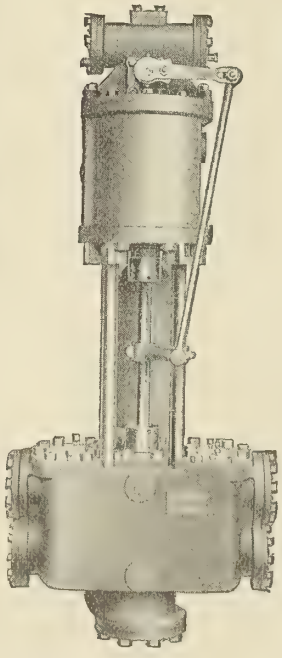
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THE McNAB CO., Bridgeport, Conn.

Or

M. M. Drake, 17 Battery Place, New York.
D. E. Ford, Merchants' Exchange Building, San Francisco, Cal.

DAVIDSON PUMPS



LONG STROKE FEED PUMPS

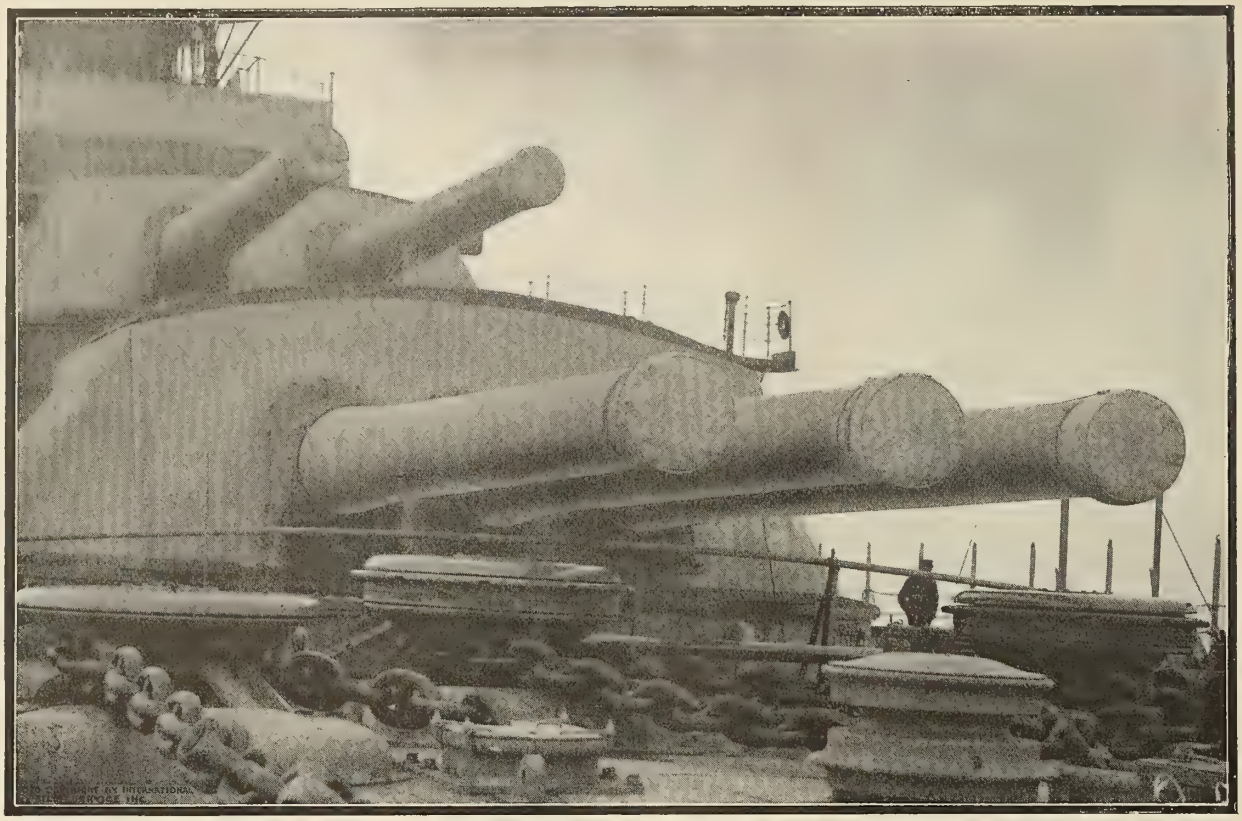
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Bilge,
Fire,
and Air
Pumps

Condensers
Evaporators
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M. T. DAVIDSON CO.

154 Nassau Street, NEW YORK

30 Oliver St., BOSTON 217 No. 15th St., PHILA.



This is the Most Powerful Naval Gun Battery in the World!

It is a part of the fighting equipment of the "NEVADA"—the latest and most formidable superdreadnaught battle-ship of the United States Navy—and consists of five 14″ long range guns mounted in tiers—three in the lower, and two in the superimposed, turret.

The "NEVADA" is equipped also with

BLAKE PUMPING MACHINERY

exclusively covering every service requirement of the ship.

In addition to this "NEVADA" equipment, it is to be noted that with few exceptions all ships built for the U. S. Navy since the time of the Civil War have been outfitted with **BLAKE PUMPS,** and nothing further need be said with regard to their design, construction, durability or reliable performance throughout this long period. Today **BLAKE PUMPS** are better designed, better built and more widely used than ever before.

Send for descriptive literature covering the Blake lines of pumping machinery.

Ask for BK 1000-43

THE BLAKE & KNOWLES STEAM PUMP WORKS

MARINE DEPARTMENT

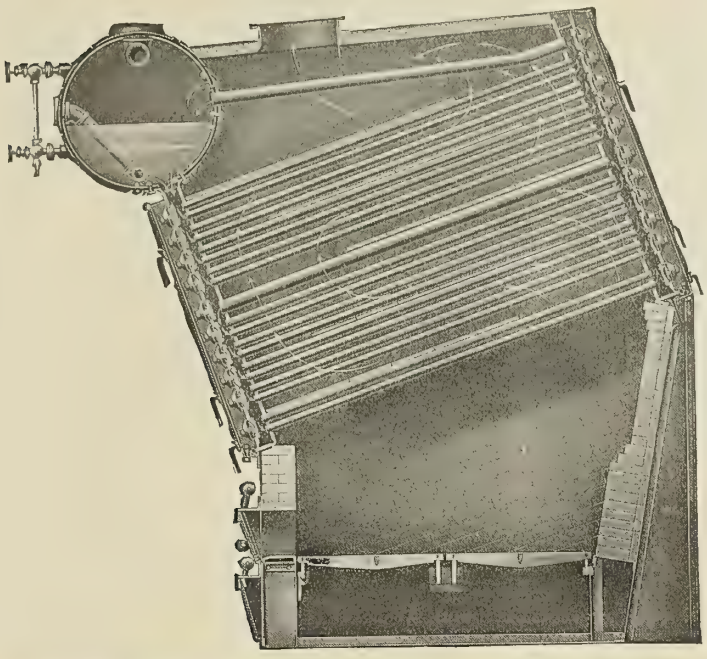
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ADOPTED BY U. S. GOVERNMENT

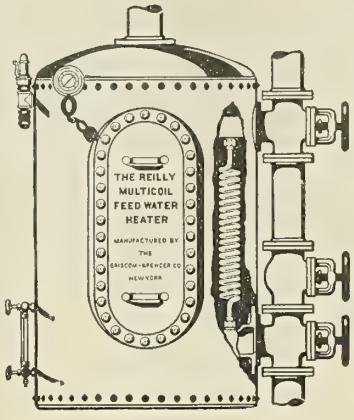


GENERATING TUBES EXPANDED. NO OTHER JOINTS.
NO NIPPLE CONNECTIONS. NO STAYBOLTS.

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MARINE ENGINES RIVER STEAMERS

REILLY MULTICOIL FEED WATER HEATERS



Stand the Test of Service

No leakage or damage due to irregular expansion and contraction—copper joints—no brazing.

The Reilly Multicoil looks like a helical spring and acts like one. All coils are interchangeable, and there is always a big door for easy access. One spare coil means ease of mind.

Write us your requirements and Bulletins will be sent

The Griscom-Russell Co.

Successors to The Griscom-Spencer Co., The Russell Engine Co., and the James Reilly Repair & Supply Co.

ENGINEERS—*Land and Marine*—MANUFACTURERS
2124 West Street Building, NEW YORK

The Babcock & Wilcox Co.

NEW YORK and LONDON

Forged Steel

Marine Water-Tube Boilers

and

Superheaters

for

Naval Vessels **Merchant Steamers**
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These boilers hold the record for economy, capacity and endurance in the Navies of the World.

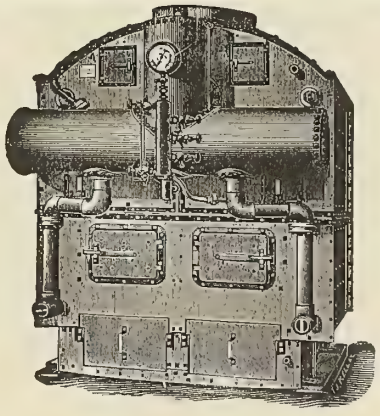
They have shown the same characteristics in the Merchant Marine. Babcock & Wilcox Boilers and Superheaters in one vessel are *saving more than 15 per cent.* over Scotch boilers in sister vessels.

Is a reduction in your coal bill of any interest to you?

Babcock & Wilcox Boilers have all essential parts heavier than corresponding parts in Scotch boilers, giving greater security against corrosion. They are lighter, safer, easier to clean and to operate than Scotch boilers, and much more efficient.

We are constantly receiving "repeat orders" from owners of merchant vessels who have had many years' satisfaction from the earlier installations.

Write us for details



We Build

Light, compact, durable, accessible, sectional

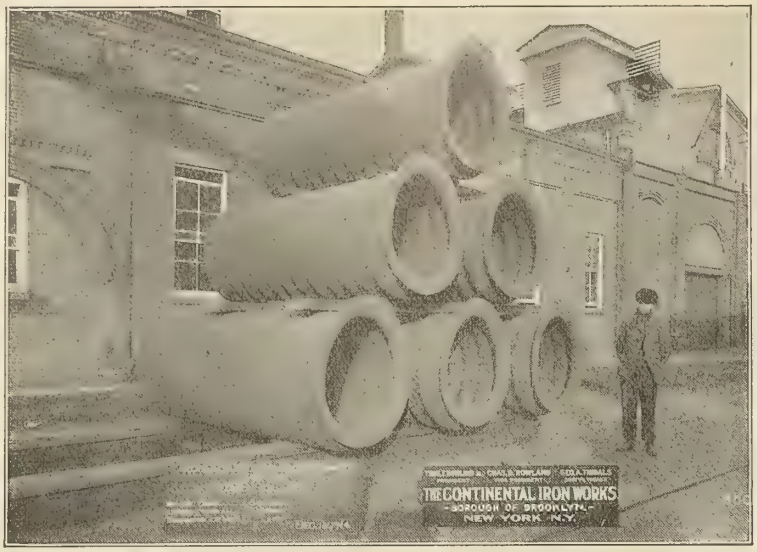
Boilers

for all marine purposes

Our new catalogue describes them, tells who has them, shows cuts of more than 330 vessels we have equipped.

Let us mail you one

ALMY WATER-TUBE BOILER CO.
PROVIDENCE, R. I.



MORISON SUSPENSION FURNACES

FOR LAND AND MARINE BOILERS

UNIFORM THICKNESS
EASILY CLEANED
UNEXCELLED STRENGTH

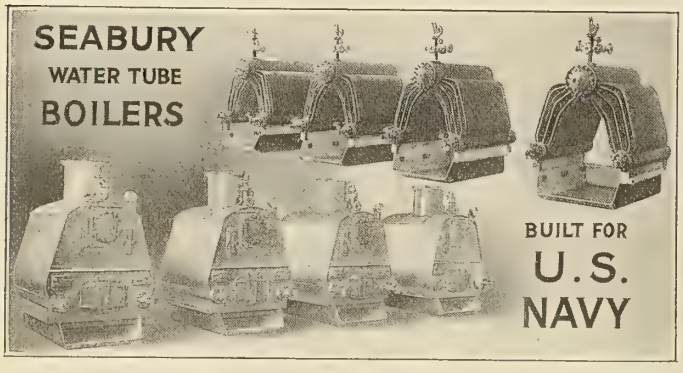
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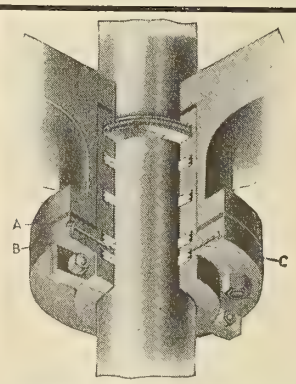
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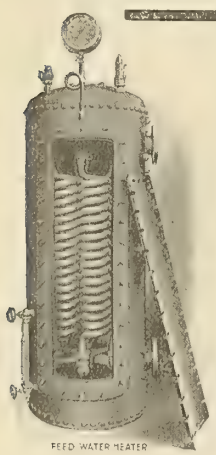
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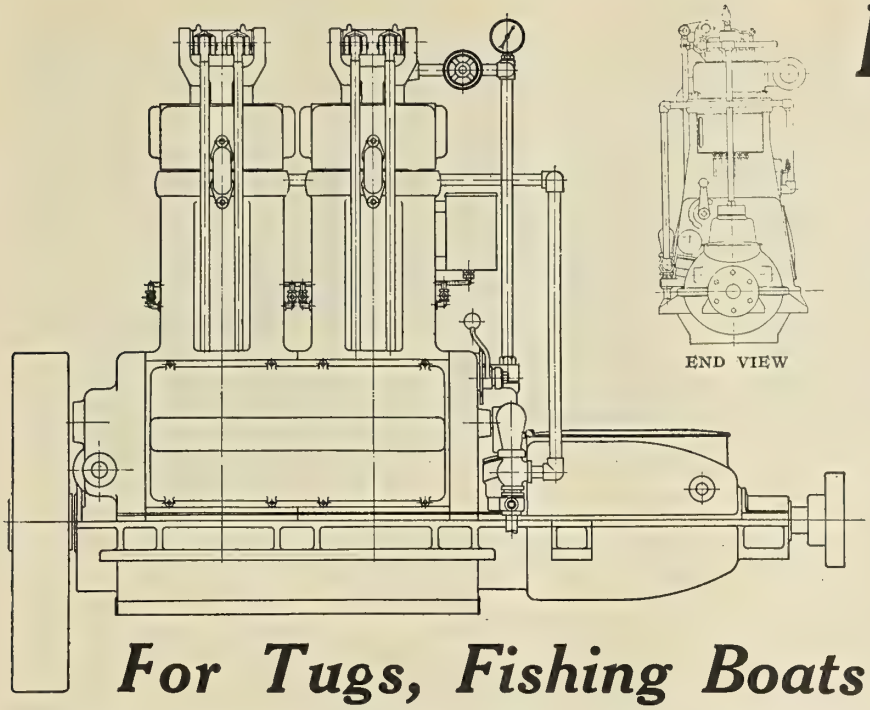
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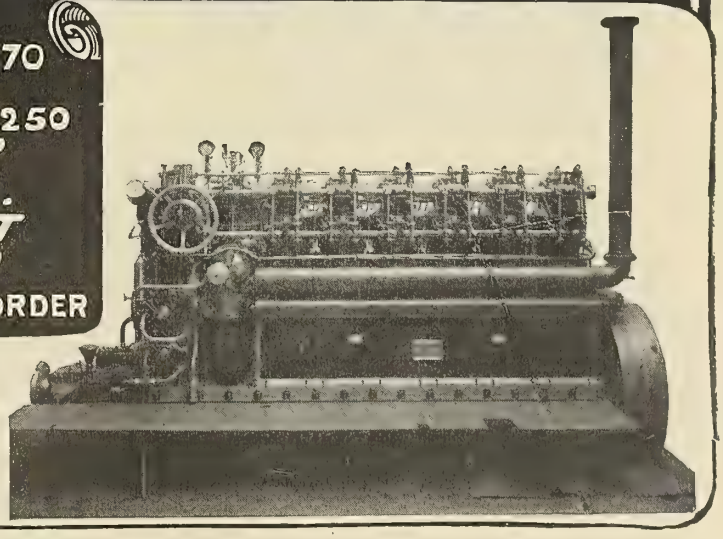
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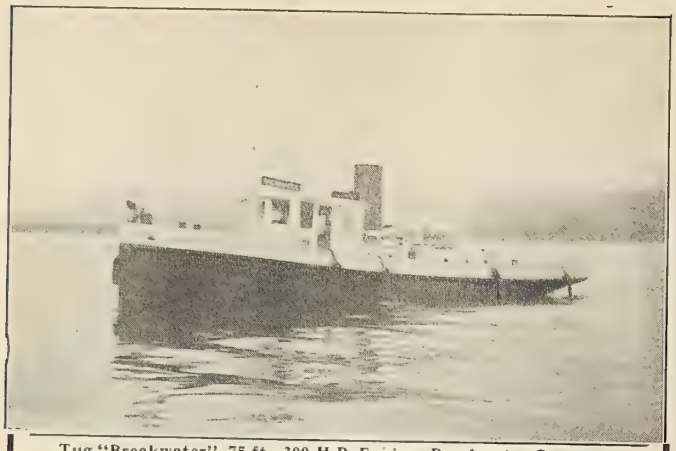
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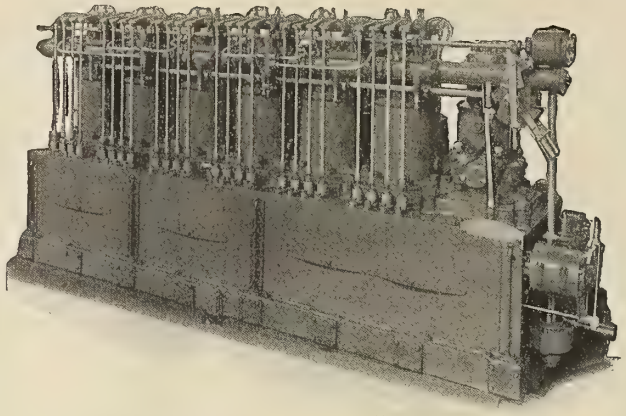
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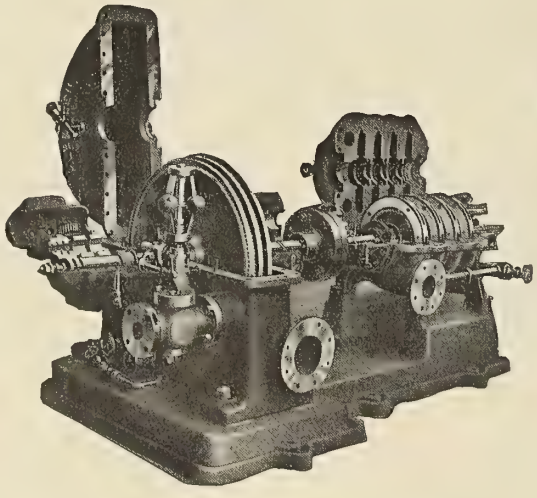
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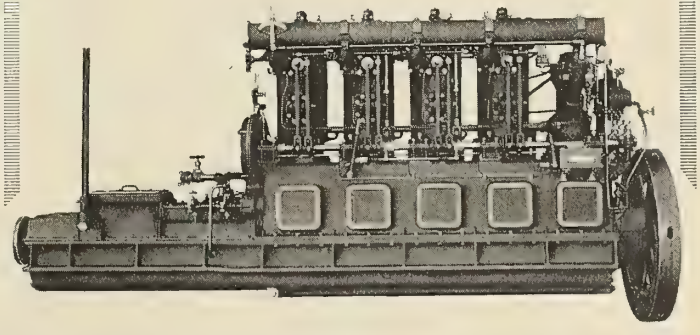
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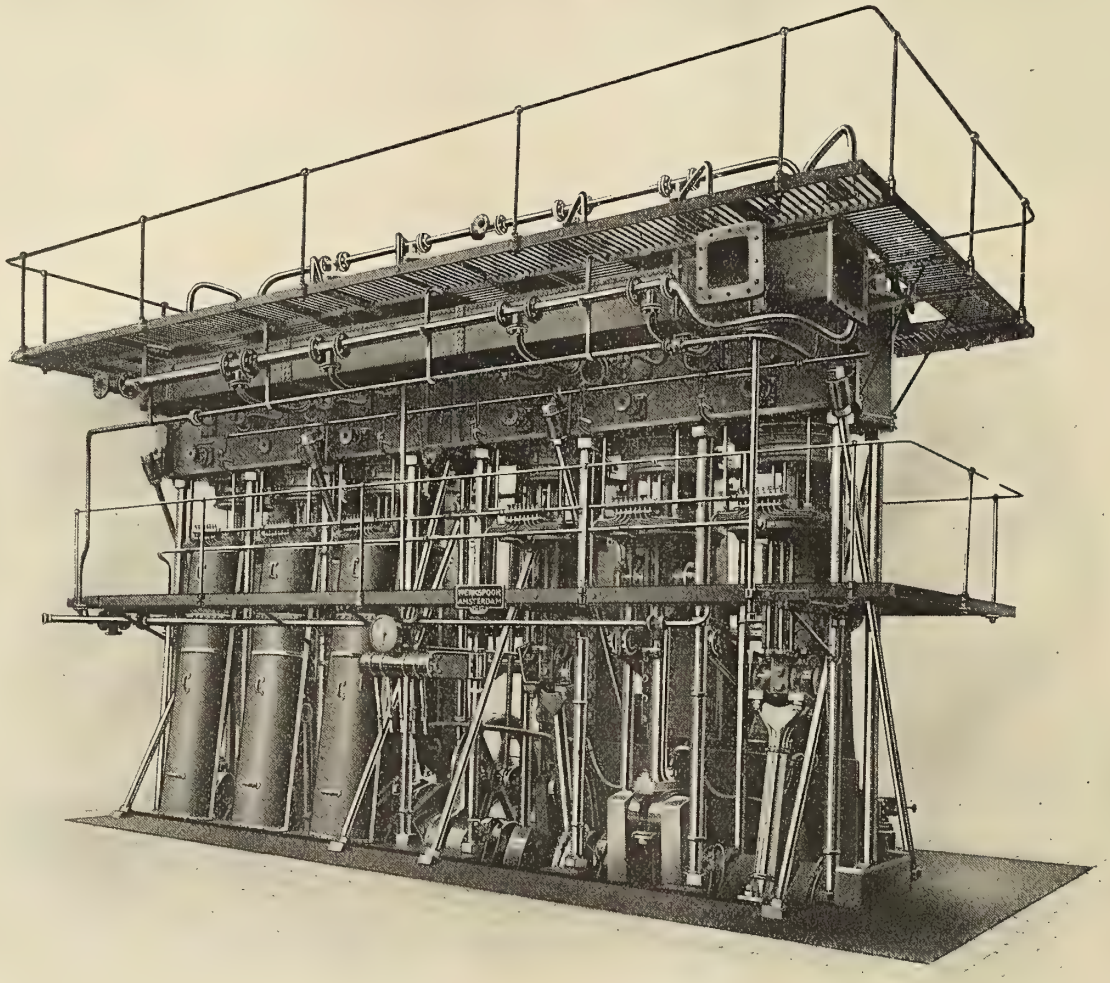
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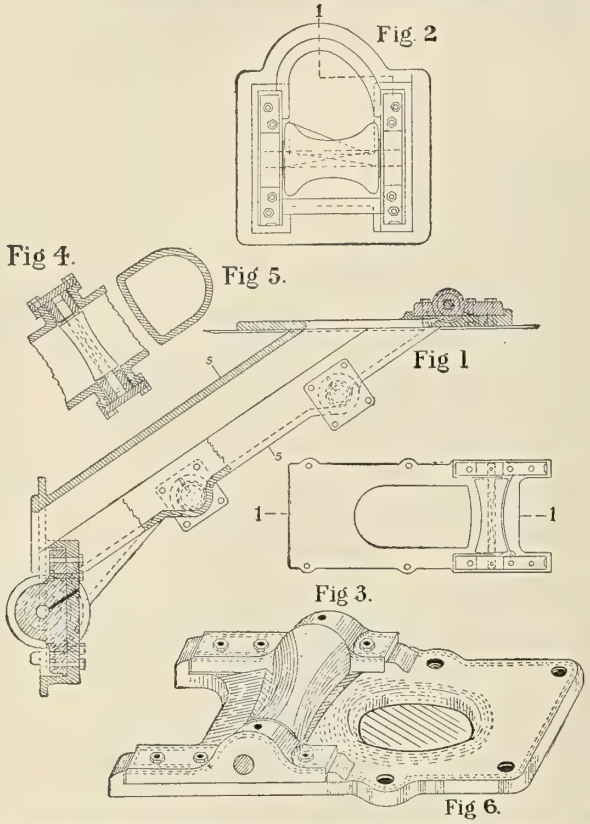
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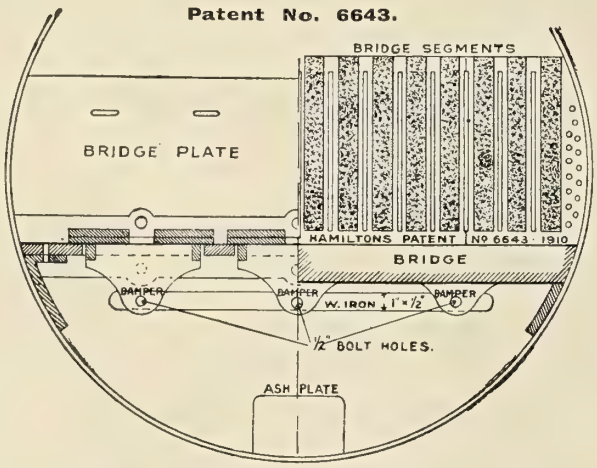
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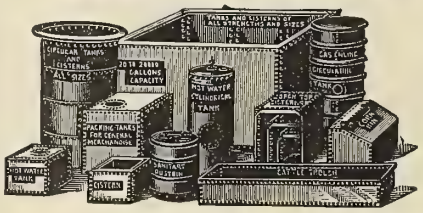
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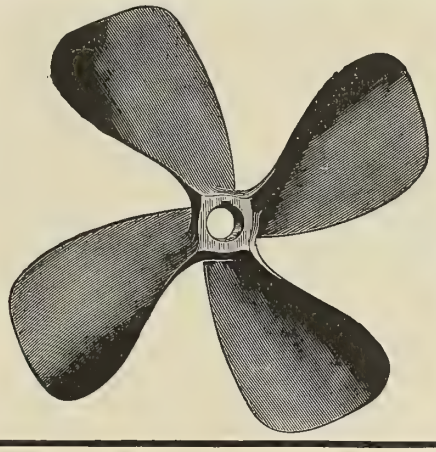
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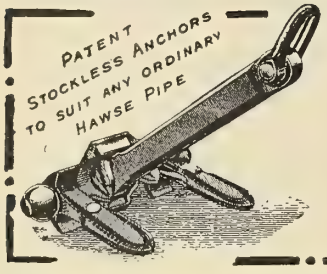
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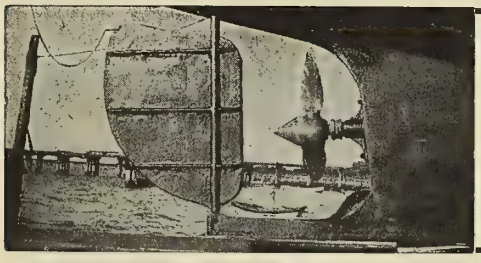
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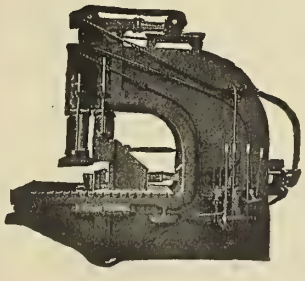
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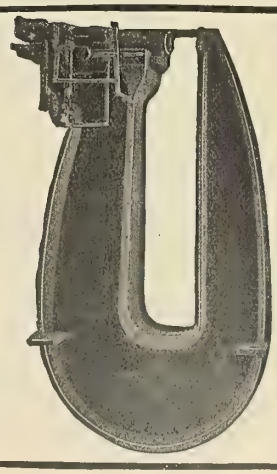
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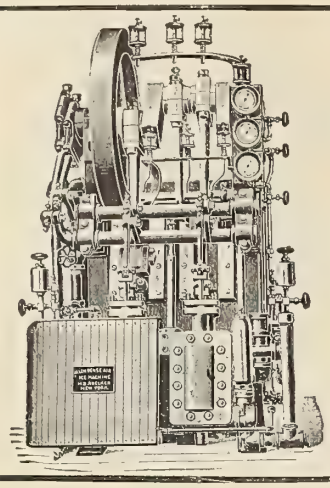
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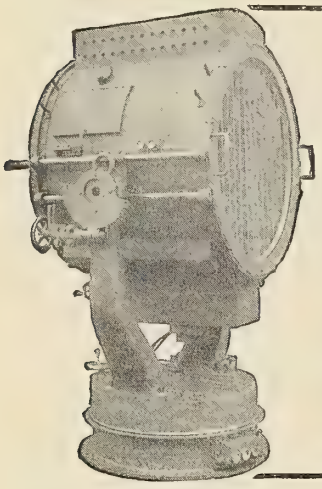
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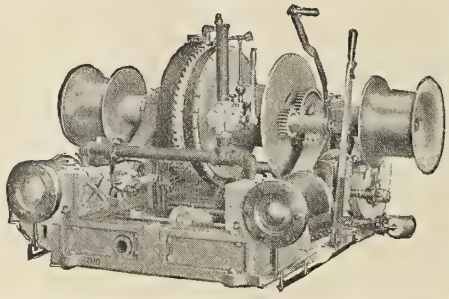
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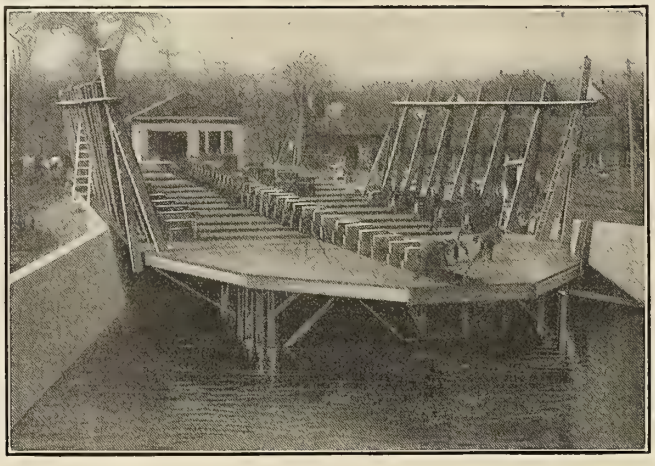
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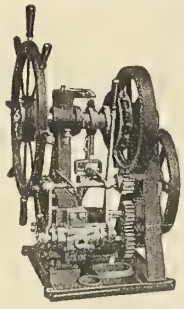
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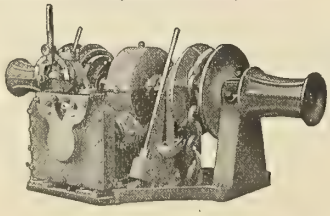


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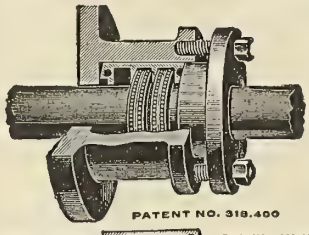
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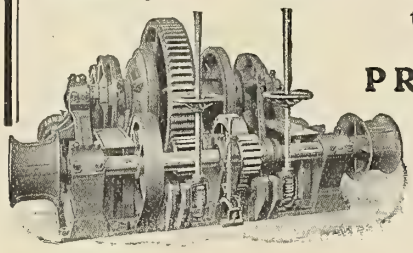
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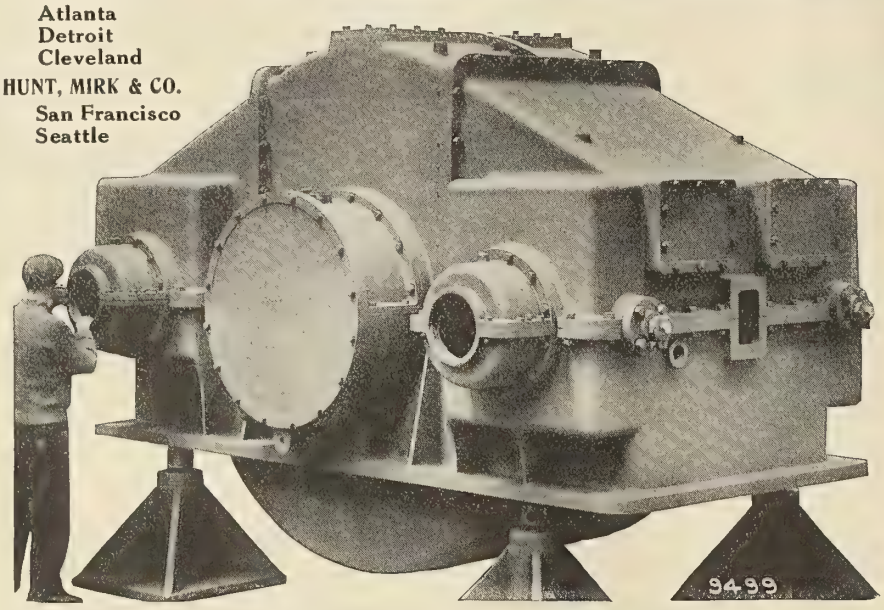
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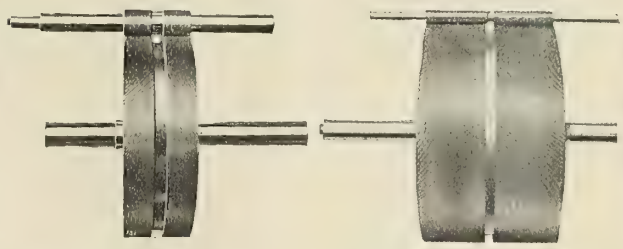
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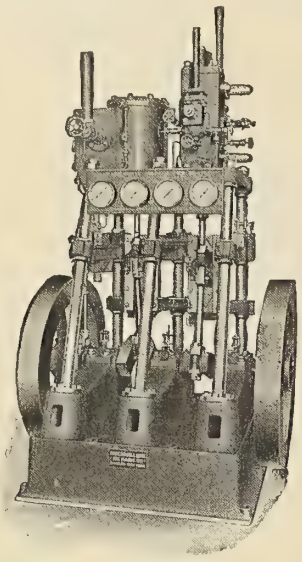
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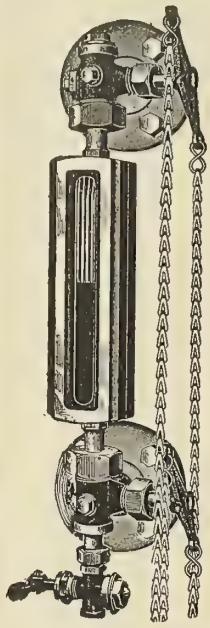
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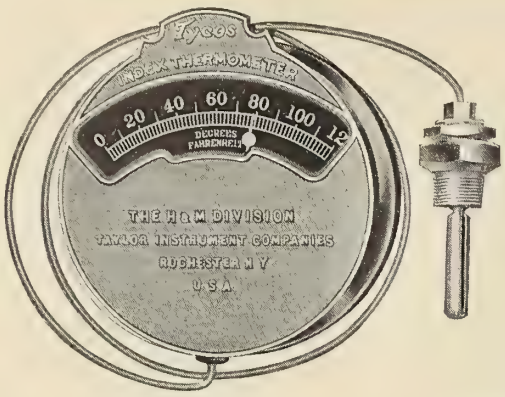
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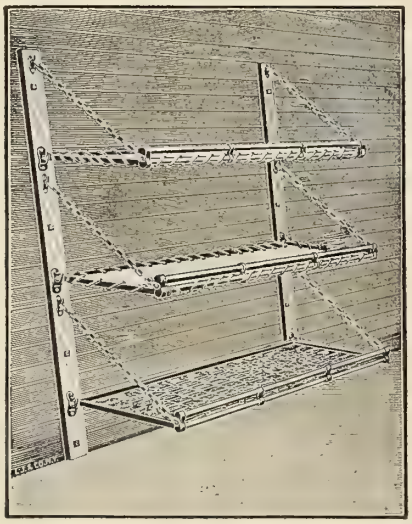
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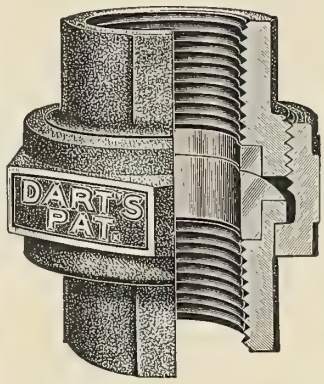
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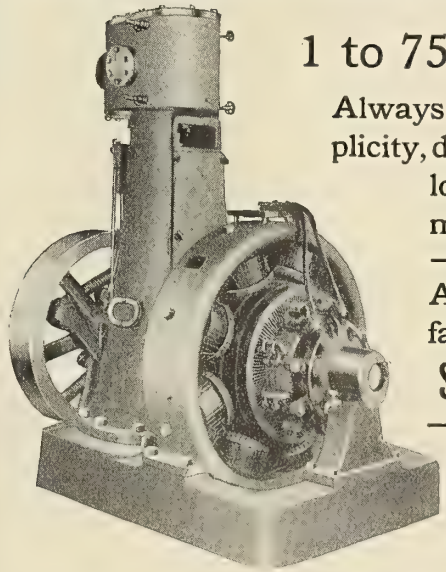
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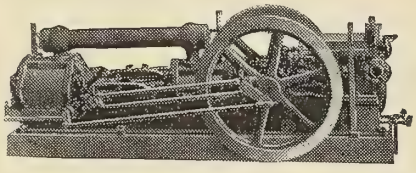


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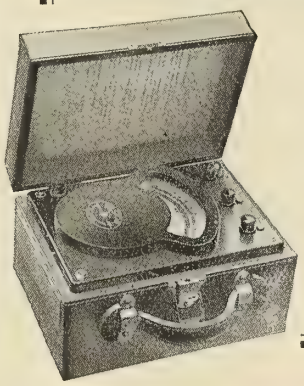
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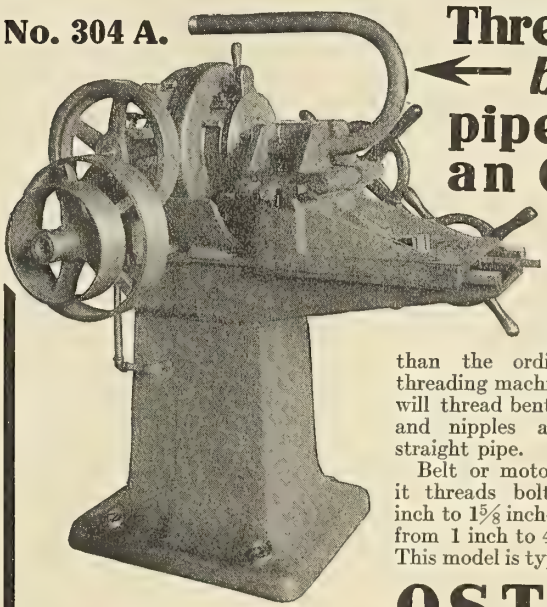
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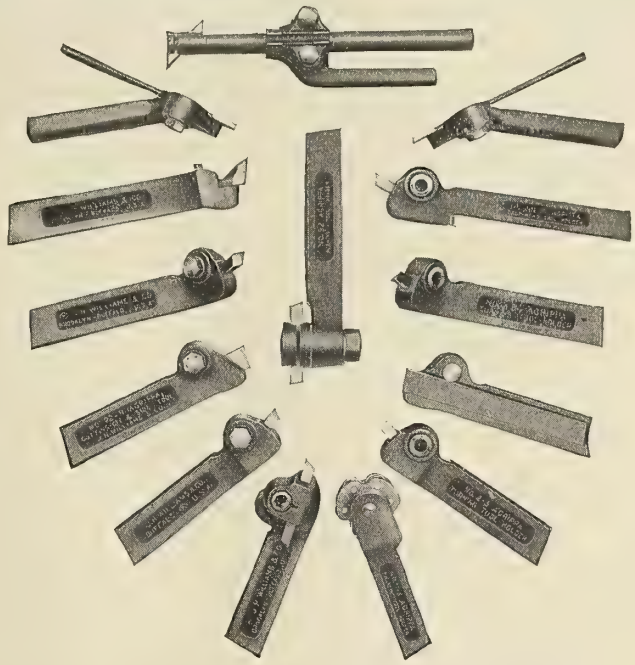
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RUBBER TILING—See INTERLOCKING RUBBER TILING AND SHEET RUBBER TILING.
SAFETY DEVICES—See LIFE SAVING DEVICES.
SAFETY VALVES—See VALVES.
SANITARY FITTINGS—See PLUMBING.
SANITARY PUMPS—See PLUMBING.
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SENTINEL VALVES—See VALVES.
SEPARATORS—PNEUMATIC—See PNEUMATIC SEPARATORS
SHAFTING—HOLLOW, SEAMLESS STEEL.
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SHAFT STEEL—See STEEL SHAFTING.
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SHIP GLUE—See MARINE GLUE.
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VENTILATING FANS—See BLOWERS.

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VERTICAL PUMPS—See PUMPS.

VOLTMETERS—See ELECTRICAL INSTRUMENTS.

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WATERPROOF CANVAS—See CANVAS, WATERPROOF.

WATERPROOF LIQUID CEMENT.
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YACHT GLUE—See MARINE GLUE.

YACHTS—See LAUNCHES AND YACHTS; also SHIPBUILDERS.

INDEX TO ADVERTISERS

PAGES

ALBANY LUBRICATING CO., New York 43
ALBERGER PUMP AND CONDENSER CO., New York 26
ALMY WATER TUBE BOILER CO., Providence, R. I. 23
ALUMINUM ORE CO., East St. Louis, Ill 13
AMERICAN BLOWER CO., Detroit, Mich 20
AMERICAN BUREAU OF SHIPPING, New York 37
AMERICAN ENGINEERING CO., Philadelphia, Pa 41
ANDREWS, WILLIAM INC., New York 3
ASBESTOS PROTECTED METAL CO., Pittsburgh, Pa. Outside Front Cover
ASHTON VALVE CO., Boston, Mass 10

BABCOCK & WILCOX CO., New York 23
BALDT ANCHOR CO., Chester, Pa 36
BALTIMORE DRY DOCKS AND SHIPBUILDING CO., Baltimore, Md. 31
BALTIMORE OAKUM CO., Baltimore, Md 50
BANTAM ANTI-FRICTION CO., Bantam, Conn 47
BATH IRON WORKS, Bath, Maine 32
BERNSTEIN MFG. CO., Philadelphia, Pa 9
BLAKE & KNOWLES STEAM PUMP WORKS, New York 22
BOLINDERS COMPANY, New York 27
BOX & CO., ALFRED, Philadelphia, Pa 36
BRIDGEPORT MOTOR CO., Bridgeport, Conn 33
BROWN, ARTHUR R., London, England ..... —
BRUNSWICK REFRIGERATING CO., New Brunswick, N. J 15
BURNOIL ENGINE CO., South Bend, Ind 25
BUTTERFIELD, W. P., LTD., Shipley, England 30

CARLISLE & FINCH CO., Cincinnati, Ohio 34
CEDERVALL & SONER, F. R. Gothenburg, Sweden 10
CHAMBERSBURG ENGINEERING CO., Chambersburg, Pa 33
CLEVELAND PNEUMATIC TOOL CO., Cleveland, Ohio 50
CLOTHEL COMPANY, THE, New York 43
COCKS, HARRY, & CO., Cardiff, Wales 32
COLUMBIAN ROPE CO., Auburn and New York Below Table of Contents, in Front of Magazine
CONTINENTAL IRON WORKS, THE, Brooklyn, N. Y 24
COX & STEVENS, New York 42
CRAIG ENGINE & MACHINE WORKS, JAS., Jersey City, N. J 26
CRANDALL ENGINEERING CO. East Boston, Mass 34
CUMMINGS SHIP INSTRUMENT WORKS, Boston, Mass. Inside Front Cover

DAKE ENGINE CO., Grand Haven, Mich 36
DART MFG. CO., E. M., Providence, R. I 49
DAVIDSON, M. T., CO., New York 21
DECKER, DELBERT H., Millerton, N. Y ..... —
DE LAVAL STEAM TURBINE CO., Trenton, N. J 45
DIXON CRUCIBLE CO., JOS., Jersey City, N. J 5
DONNELLY, W. T., New York ..... 33 and 42
DURABLE WIRE ROPE CO., Boston Mass 34

ECKLIFF AUTOMATIC BOILER CIRCULATOR CO., Detroit, Mich. 16
ELWELL-PARKER ELECTRIC CO., Cleveland, Ohio ..... —
ENGBERG'S ELECTRIC & MECHANICAL WORKS, St. Joseph, Mich 49
EUREKA FIRE HOSE MFG. CO., New York 52

FARLEY CO., EDWARD P., Chicago, Ill 42
FERDINAND & CO., L. W Boston, Mass 42
FLETCHER CO., W. & A. Hoboken, N. J 32
FORE RIVER SHIPBUILDING CORPORATION, Quincy, Mass 31
FRANCE PACKING CO., Philadelphia, Pa 24

GAS ENGINE & POWER CO., and CHAS. L. SEABURY & CO., Consolidated, Morris Heights, N. Y 24
GENERAL ELECTRIC CO., Schenectady, N. Y 19
GOLDSCHMIDT THERMIT CO., New York 52
GREENE, TWEED & CO., New York ..... Outside Back Cover
GRISCOM-RUSSELL CO., New York 23

HAMILTON, A. & SONS, Cardiff, Wales 30
HOLMES METALLIC PACKING CO., Wilkesbarre, Pa 37
HOLZAPFELS AMERICAN COMPOSITIONS CO., New York 10
HOUGH, EDWARD S., San Francisco, Cal 42
HYDE WINDLASS CO., Bath, Me ..... Inside Front Cover

INDEPENDENT PNEUMATIC TOOL CO., Chicago and New York 37
ISHERWOOD, J. W., London, England 29

JERGUSON GAGE & VALVE CO., Boston, Mass 47
JOHNS-MANVILLE CO., H. W., New York 17

KERR TURBINE CO., Wellsville, N. Y ..... —
KIND, ING. P., & CO., Turin, Italy 25
KROESCHELL BROS., ICE MACHINE CO., Chicago, Ill 46

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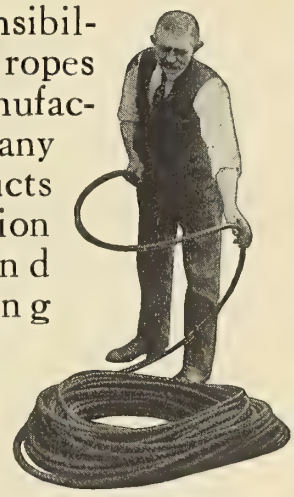
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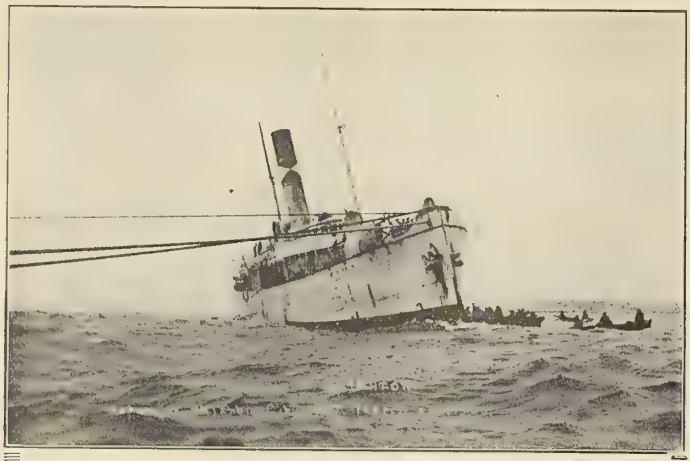
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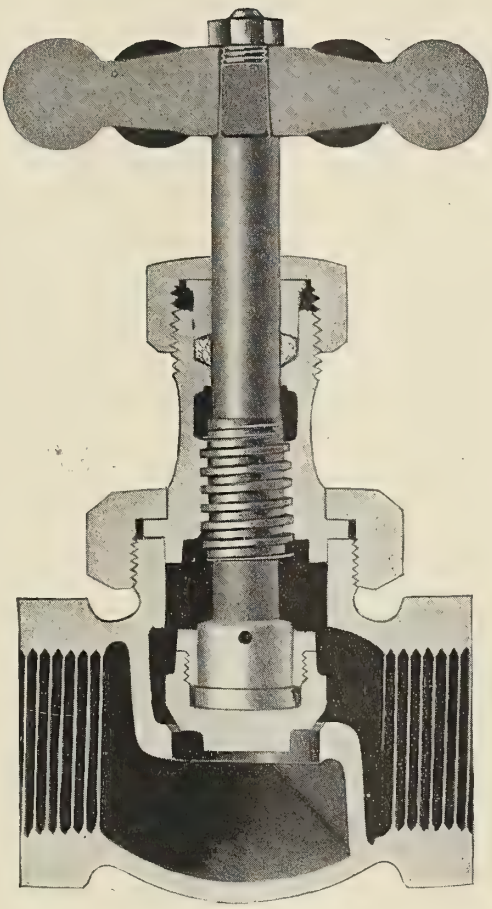
	PAGES
LANE, C. M., LIFE BOAT CO., Brooklyn, N. Y.	50
LIDGERWOOD MFG. CO., New York	34
LOCOMOTIVE SUPERHEATER CO., New York	11
LUNKENHEIMER CO., THE, Cincinnati, Ohio	Inside Front Cover
McMYLER-INTERSTATE CO., Cleveland, Ohio	36
McNAB CO., THE, Bridgeport, Conn.	21
McNAB & HARLIN MFG. CO., New York	Inside Back Cover
MANNING, MAXWELL & MOORE, Inc., New York	35
MERRILL-STEVENS CO., Jacksonville, Fla.	32
MIETZ MACHINE WORKS, AUGUST, New York	27
MORSE, ANDREW J., & SON, INC., Boston, Mass.	50
MORSE TWIST DRILL & MACHINE CO. New Bedford, Mass.	54
MOTT IRON WORKS, J. L., New York	31
NATIONAL MOTOR BOAT SHOW, New York	12
NATIONAL TUBE CO. Pittsburgh, Pa.	50
NEW LONDON SHIP & ENGINE CO., Groton, Conn.	27
NEWPORT NEWS SHIPBUILDING & DRY DOCK CO., Newport News, Va.	31
NEW YORK BELTING & PACKING CO., New York	7
NICHOLSON FILE CO., Providence, R. I.	41
NILES-BEMENT-POND CO., New York	31
NORWALK IRON WORKS, South Norwalk, Conn.	50
OSTER MANUFACTURING CO., Cleveland, Ohio	51
PARSONS MARINE STEAM TURBINE CO., New York	27
PEERLESS RUBBER MFG. CO., New York	14
PLYMOUTH CORDAGE CO., North Plymouth, Mass.	56
POCAHONTAS FUEL CO., New York	33
POWELL, WILLIAM CO., THE Cincinnati, Ohio	4
ROELKER, H. B., New York	34
ROSS SCHOFIELD CO., New York	10
SAMSON CORDAGE WORKS, Boston, Mass.	54
SANDS & SON CO., A. B., New York	41
SCHUTTE & KÖRTING CO., Philadelphia, Pa.	52
SEATTLE CONSTRUCTION & DRY DOCK CO., Seattle, Wash.	32
SHERIFFS MFG. CO., Milwaukee, Wis.	37
SIMPLEX ELECTRIC HEATING CO., Cambridgeport, Mass.	50
SMOOTH-ON MFG. CO., Jersey City, N. J.	43
SOUTHERN BEDDING CO., THE, Baltimore, Md.	48
SOUTHWARK FOUNDRY & MACHINE CO., Philadelphia, Pa.	8
SPRAGUE ELECTRIC WORKS, New York	30
STANDARD MOTOR CONSTRUCTION CO., Jersey City, N. J.	26
STANDARD WATER SYSTEMS CO., New York	24
STAR BRASS MFG. CO., Boston, Mass.	21
STARRETT, L. S., CO., Athol, Mass.	12
STEWARD, ROBERT BRUCE, New York	12
TALBOT BOILER CO., New York	18
TAYLOR INSTRUMENT COMPANIES, Rochester, N. Y.	48
TERRY STEAM TURBINE CO., Hartford, Conn.	Facing Leading Article
THORN & HODDLE ACETYLENE CO., Ltd., London, England	30
TIETJEN & LANG DRY DOCK CO., Hoboken, N. J.	32
TROUT, H. G., CO., Buffalo, N. Y.	31
UNION DRY DOCK AND REPAIR CO., Weehawken, N. J.	42
UNITED STATES METALLIC PACKING CO., Philadelphia, Pa.	37
VALK & MURDOCH CO., Charleston, S. C.	32
WARD, CHAS. ENGINEERING WORKS, Charleston, W. Va.	23
WATERBURY CO., New York	55
WATTS, J. MURRAY, Philadelphia, Pa.	42
WEIMER CHAIN & IRON CO., Lebanon, Pa.	49
WELIN MARINE EQUIPMENT CO., Long Island City, N. Y.	6
WERKSPOOR, Amsterdam, Holland	28
WESTINGHOUSE MACHINE CO., East Pittsburgh, Pa.	44
WESTON ELECTRICAL INSTRUMENT CO., Waverly Park, Newark, N. J.	51
WHITING JOHN L.—J. J. ADAMS CO., Boston, Mass.	45
WHITLOCK CORDAGE CO., New York	54
WILLIAMS & CO., J. H., Brooklyn, N. Y.	53
WILLIAMS VALVE CO., D. T., Cincinnati, Ohio.	46
WOLVERINE MOTOR WORKS, Bridgeport, Conn.	5

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